cable alone; while with the duplicate cables all cars can, at any time, be transferred to the second rope without interruption to traffic.

Considering the success of the duplicate system, and the great advantages secured by its adoption, we feel justified in giving a description of some of the principal details, showing how the ropes are worked independently.

At the point where the cable is first carried into the conduit, sheaves 4 ft. in diameter (called elevating sheaves) are used to elevate the rope to a line where it may be received into the gripper. On single rope roads these sheaves are set on the line of slot, and grip guided around said elevating sheaves, then brought to where the cable is received by a very sharp reverse curve in slot and track rails, making an offset in the slot, of 4½-ins. in a length of less than 5 ft. As these short reverse curves are troublesome, I abandon them, placing the sheaves in a frame having trunnions on the ends at which the wheel tilts.

This tilting is accomplished by a horizontal lever, moving in a vertical plane, and is operated by the grip as the car passes. The normal line of the elevating sheave is in the line of the travel of the grip, and as the car approaches, the grip rides on a horizontal lever, which is depressed by the movement and weight of the grip, and in turn tilts the sheave. The grip then passes, the sheave resumes its former position and the cable is laid between the grip jaws. Machinery thus operated, weighs several hundred pounds, and to manipulate it with safety, every two or three minutes the year round, while the cable is moving 8 or 10 miles per hour, necessitates close calculation. To allow one second of time for the performance of the operation above described, a run of from 10 to 12 ft. is indispensable, and for this reason the horizontal levers are about 10 ft. long, for if the work were performed with 2 or 3-ft. movement of the car, the contact of any metal bar with the grip would be as destructive as blows from a sledge hammer. The cable having been thus received into the gripper at the starting point, is carried to the end of the line, passing freely through the grip jaws in bringing cars to a standstill. Reference will be made to the grip later on.

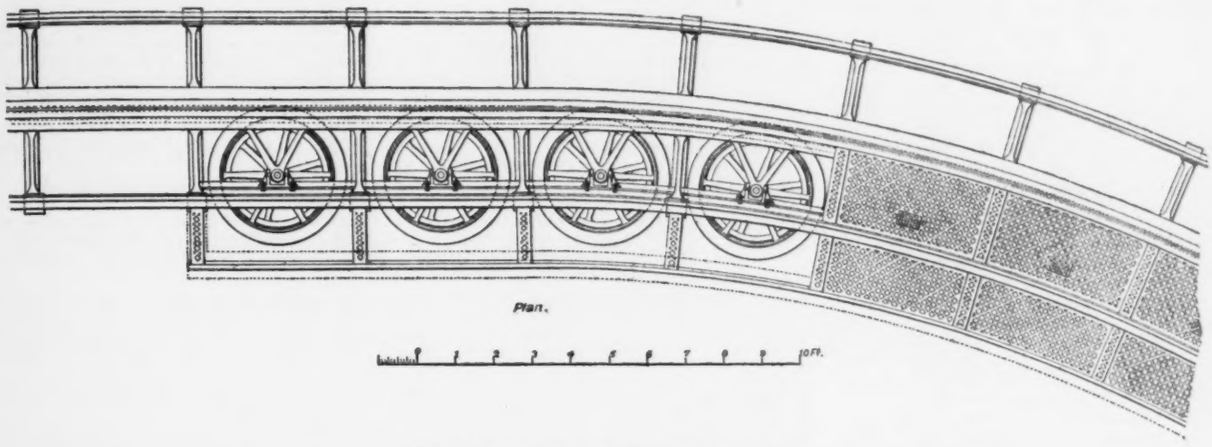

Fig. 2.—Traction Rope Railways.—Plan on curve.

CONDUIT, PULLEY VAULTS AND DRAINAGE.

Complete drainage must be provided for conduit and vaults. In our experience, the *débris* from the street passes through the slot, obstructing the free flow of water, and where carrying pulleys are placed in the main, conduit water collects about the wheel. While this is oojectionable in summer, it works untold damage to cable and wheels in severe winter weather. I have known of instances where a majority of the wheels have been totally ruined by an attempt to start and run the road after a short stoppage on a cold day. The wheels being stationary, the moving rope soon made sad havoc.

Where carrying pulleys are placed in main conduit, the wheels are necessarily small, conduit deep, and first cost of construction excessive. To avoid these objectionable features, I introduced carrying pulley vaults, see Fig. 1, at intervals of 35 ft., giving ample space for pulleys of desired diameter, and also for the admission of a man having charge of said pulleys.

In excavating for structural work, a sewer-pipe is laid beneath the main conduit, from one pulley vault to the other, and the grade may be independent of that of the street. Outlets are provided where necessary, and are connected with street sewer if possible.

This system of drainage allows the unobstructed passage of water from the main conduit into the vaults, then to the city sewers, thus securing perfect drainage for the entire road.

By adoption of the above-mentioned vaults, we are enabled to reduce the size of the main conduit to a depth of 2 ft., and a width of 15 ins. at largest section, thereby materially reducing the first cost of construction.

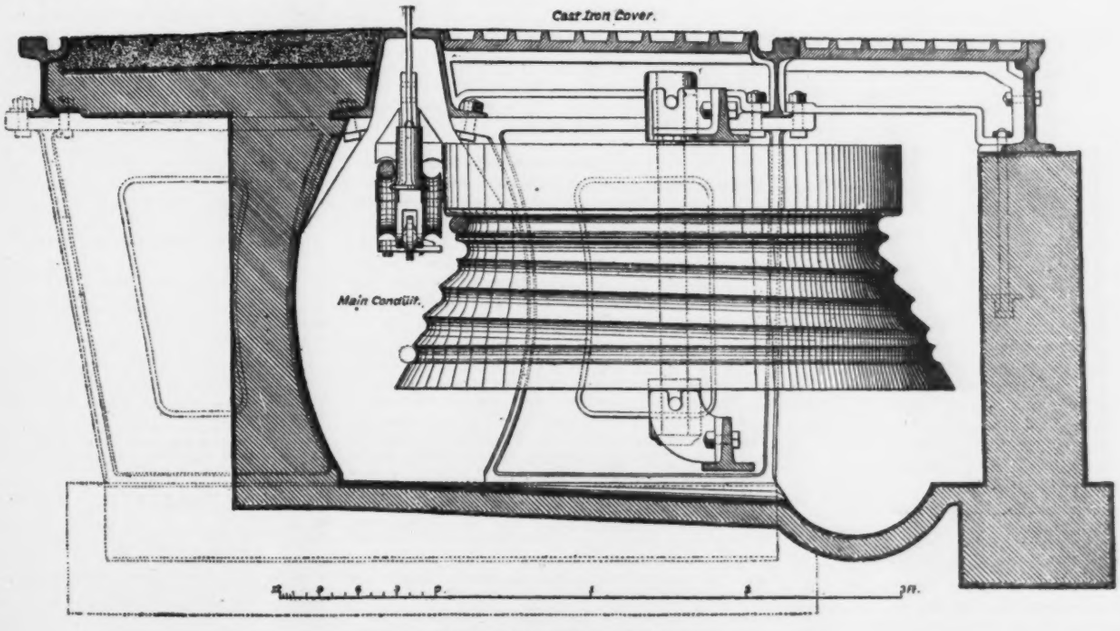

Fig. 3.—Traction Rope Railways.
Transverse section at curve, showing horizontal wheels in position and end view of grip.

The slot rail used allows the grip to be carried nearer the streets surface than in any other system, and is formed with oval corners, preventing the fastening of horses' shoes, which are endangered by sharp cornered rails.

CARRYING PULLEYS.

In examining the working and condition of carrier pulleys on several cable roads, I concluded that there was room for improvement in their design, and also that the journal boxes for same were capable of betterment. A poorly balanced wheel will injure the cable and assist in its own destruction, and it is my opinion that there are roads on

Traction Rope Railways.*

BY D. J. MILLER, MEMBER OF THE WESTERN SOCIETY OF ENGINEERS.

[Read March 1, 1887.]

In the fall of 1882, I had the pleasure of presenting to this Society a brief description of the Chicago cable roads, and in said description advocated the introduction of duplicate cables, considering duplication of the motive power of vital importance to the perfection of this system of traction. Since then I have been able to carry my theory into practice to a certain extent, and have had the satisfaction of demonstrating the feasibility of what was at that time an untried plan.

Four years ago there were, in the United States, 36¼ miles of cable road in operation and under construction. Jan. 1, 1887, there were 116 miles additional in operation and under construction, making a total of 152¼ miles, and from present indications it is fair to assume that at least 100 miles will be added to the above figure during the ensuing year.

While some of the later roads contain valuable improvements, there are others the designs and workmanship of which could not well be worse. Within the last year or two, many unscrupulous speculators have manifested a decided interest and activity in cable work, attempting, especially of late, to palm off on the public what they are pleased to designate as some particular system of cable traction, the so-called system in reality containing not one element requisite to a good road; but this method of propulsion has grown in popularity so rapidly that many capitalists willingly invest in cable roads regardless of their merits or demerits. We have known of millions being expended in constructing lines which, when finished, were inferior to animal traction, so far as service to the public was concerned, and from a financial standpoint also, the horse road would be preferable. Nevertheless we do not know of one in operation not paying a fair interest on the first cost.

Unless investors exercise extreme caution, and closely investigate before absolutely committing themselves to any plans or schemes submitted for approval, the increasing number of inferior roads, together with bad management in operation, will result in arousing general indignation, and public sentiment will eventually bear strongly against their further extension and greatly interfere with future progress in this direction.

A street railway, under the cable system, becomes a colossal machine, and its efficiency is unquestionable, provided the component parts are properly arranged and cared for, but with disinterested and careless or ignorant attendance, demoralization and destruction must surely follow in the course of events.

The serviceableness of a road, no matter how meritorious the system, can and will be materially affected by mismanagement, which fact cannot be too forcibly impressed on stockholders, as in this case it means smaller dividends and costly repairs.

We find records of patents, both foreign and American, long since expired, the drawings and specifications of which cover the same ground that inventors of later date have endeavored to secure by letters patent. For instance, in an English patent granted in 1845, a tube between the rails is illustrated with slot in center and a rope to draw the car. The gripper was provided with movable parts for grasping the cable, and had wheels intended to move on rails or guides in the conduit.

The principles demonstrated in the above-mentioned patent are carried out in the roads of to-day.

To show the development forty years ago in cable traction, we give a few extracts from a description of the London & Blackhall Railway, published in 1832, a copy of which was kindly furnished us by Gen. CHARLES FITZSIMMONS.

"A pair of powerful marine engines were erected at each end of the line, to which the drums for winding up the rope were connected by friction clutches. The drums were of cast iron, each 23 ft. in diameter, and their circumference revolved on an average of 26 miles per hour. The rope was 5¾-ins. in circumference and being upward of six miles in length, weighed about 40 tons, and was sufficiently long to reach from one end of the line to the other, when somewhat more than one-half the rope was wound upon one of the drums. The cable was supported along the line by cast-iron wheels or sheaves, 3 ft. in diameter and 7½-ins. in width, which not only prevented the rope from trailing upon the ground, but also guided it around the curved portions of the line. The carriages were connected to the rope in such a manner that they could be instantly released without stopping the motion of the rope, and again connected if required." In the foregoing we find the following points of interest: First, the cars could be detached from and again attached to the rope while the latter was in motion. Second, the cable moved at the rate of 26 miles per hour. Third, the winding drums were of sufficient capacity to store three miles of 1⅞-in. rope, weighing 20 tons. Fourth, these drums were connected to the engines by friction clutches.

As copies of foreign patents were not formerly filed in the United States Patent Office, it is probable that GARDNER was not cognizant of the existence of a similar English patent, when he obtained the American patent in 1858 on the conduit and slot for traction rope railways.

In 1869 a patent was issued to Gen. G. T. BEAUREGARD covering some minor details, but the drawing represented a grip having jaws that could close on a moving cable, and the friction caused by this contact would start the car as easily as might be desired. In this design, the cable was above the car.

GARDNER'S specifications refer to a grip (calling it a catch) connected to the car, projecting through the slot, and engaging with the cable in the conduit, and these inventions embodied the rudimental principles of the present system of traction rope railways. Forty-five patents on traction were issued in the United States prior to 1875. Of this number, four were granted to Mr. A. S. HALLIDIE of San Francisco, on running and carrying ropes, but were not applicable to the propulsion of street cars.

In 1872 Mr. HALLIDIE obtained his first patent on the grip, the drawings of which illustrated a vertical shank intended to extend from the floor of the car, through the slot and into the conduit, with wheels or jaws on the lower end for gripping the cable, but the principal points were not covered in the patent.

In constructing the first cable road, Clay street Hill, San Francisco, the Gardner tube, and above described principles of the Hallidie grip, together with the Beauregard grip jaw were adopted, with modifications and improvements.

The second road constructed was on Sutter street, San Francisco, and this differed somewhat in detail from the line on Clay street Hill. The general arrangement of the grip was considered so satisfactory that it was afterward adopted on nearly every road in San Francisco, and this grip, with other improvements, was designed by Mr. ASA E. HOVEY, the engineer of the road, who has for the past six years been connected with the Chicago roads.

To San Francisco belongs the credit of operating the first street surface cable road; yet Philadelphia by the invention of Gardner, must be accredited with the tube or conduit. But beyond question the undertaking in Chicago was attended with the greatest risk, as it had always been supposed that such a road could not be successfully operated in a cold climate.

To Mr. HOLMES we must concede great foresight,

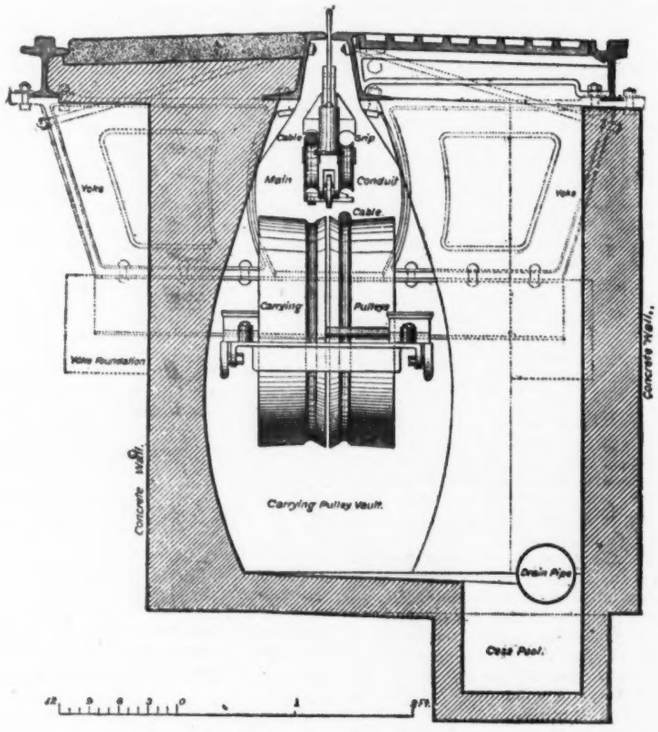

Fig. 1.—Traction Rope Railways.

and to him the cable road owes advancement and superiority of construction as well. When the Chicago roads were projected, there were but sixteen miles of cable road in operation in the world, and during the year 1881, the lines constructed in the above-mentioned city were on a larger scale, and more improved in detail, than anything of the kind previously built.

From the beginning the evolution has been gradual, until we now have a system destined, doubtless, to entirely supersede animal traction, wherever the traffic will guarantee the necessary outlay.

While single rope roads can be, and are operated successfully, they are nevertheless not entirely satisfactory, owing to the frequent stoppage for repairs, whereby the public is greatly discommoded, not to mention the money loss of the railroad company, and to overcome this acknowledged defect we have duplicated the motive power throughout. All machinery must be especially designed for its work, and no detail neglected, as the operating expense of motive power is governed almost entirely by its arrangement, as is also the continuous running of the cars.

Machinery and cables cannot give as good service in constant use as when the necessary time can be devoted to inspection and repairs; and on single rope roads, the two or three hours available in the morning are not sufficient to thoroughly inspect the

*From Journal of the Association of Engineering Societies; May, 1887.

cable alone; while with the duplicate cables all cars can, at any time, be transferred to the second rope without interruption to traffic.

Considering the success of the duplicate system, and the great advantages secured by its adoption, we feel justified in giving a description of some of the principal details, showing how the ropes are worked independently.

At the point where the cable is first carried into the conduit, sheaves 4 ft. in diameter (called elevating sheaves) are used to elevate the rope to a line where it may be received into the gripper. On single rope roads these sheaves are set on the line of slot, and grip guided around said elevating sheaves, then brought to where the cable is received by a very sharp reverse curve in slot and track rails, making an offset in the slot, of 4½-ins. in a length of less than 5 ft. As these short reverse curves are troublesome, I abandon them, placing the sheaves in a frame having trunnions on the ends at which the wheel tilts.

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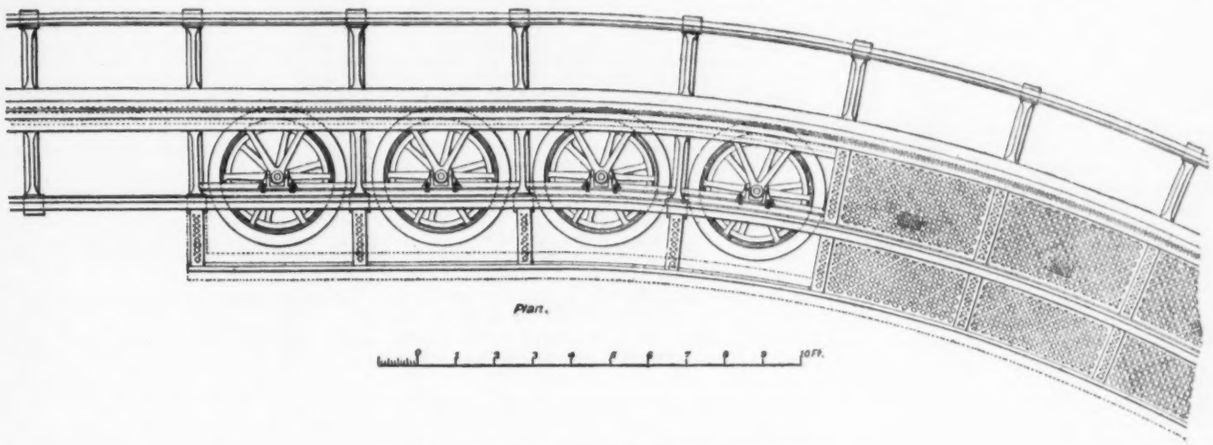

Fig. 2.—Traction Rope Railways.—Plan on curve.

CONDUIT, PULLEY VAULTS AND DRAINAGE.

Complete drainage must be provided for conduit and vaults. In our experience, the *débris* from the street passes through the slot, obstructing the free flow of water, and where carrying pulleys are placed in the main, conduit water collects about the wheel. While this is objectionable in summer, it works untold damage to cable and wheels in severe winter weather. I have known of instances where a majority of the wheels have been totally ruined by an attempt to start and run the road after a short stoppage on a cold day. The wheels being stationary, the moving rope soon made sad havoc.

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This system of drainage allows the unobstructed passage of water from the main conduit into the vaults, then to the city sewers, thus securing perfect drainage for the entire road.

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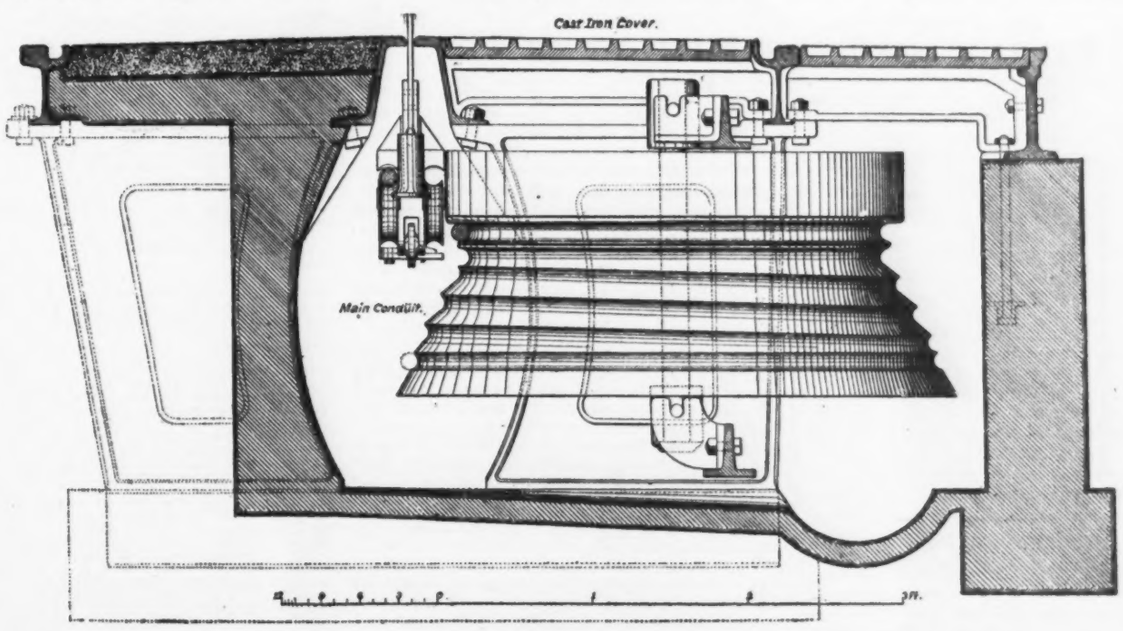

Fig. 3.—Traction Rope Railways.
Transverse section at curve, showing horizontal wheels in position and end view of grip.

The slot rail used allows the grip to be carried nearer the streets surface than in any other system, and is formed with oval corners, preventing the fastening of horses' shoes, which are endangered by sharp cornered rails.

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In examining the working and condition of carrier pulleys on several cable roads, I concluded that there was room for improvement in their design, and also that the journal boxes for same were capable of betterment. A poorly balanced wheel will injure the cable and assist in its own destruction, and it is my opinion that there are roads on

which the carrying pulleys alone cost more than the cable.

I have endeavored to design a pair of wheels sufficiently wide to prevent the rope from leaving same; also have them large and light enough to move slowly and easily on the journal boxes.

The carrying pulleys of this system are 24 ins. in diameter over flanges, and 6½ in. face. Each wheel weighs 39 lbs. independent of shaft. The journals are seven-eighths inch in diameter and 3½ ins. long, running in a composition box which was made up especially for the purpose. This metal, under the load and speed, has served with absolutely no attention for six months.

On the Tenth avenue cable road, in New York, there are upward of 1,900 carrying pulleys, half of them in constant operation for 22 hours a day.

Two men only, at $1.75 each, take entire charge of all wheels connected with the road, starting at one end of the line in the morning and arriving at the terminus at the close of the day. These men walk slowly over the route, listening to the running of pulleys as they pass same. Should they expose each pair of wheels, there would be 950 covers, weighing 250 lbs. apiece, for them to remove and replace, and at best not more than 40 could be examined in one day, consequently were it not for the afore-mentioned arrangement of boxes, men would be needed every few blocks on the avenue. This road has been in operation eighteen months, and the original wheels are still in use, several of which we have calipered, and find no perceptible wear.

With all this in their favor, we have to record one fault, and that is their resonance. The ringing sound has been distinguished for a distance of 200 ft. when the street was perfectly quiet, and this can only be totally destroyed by lining the sheaves with a non-metallic substance, an expenditure hardly justifiable except on streets used exclusively for residence, as the noise is not particularly noticeable on a business thoroughfare.

CURVES. (SEE FIGS. 2 AND 3.)

The conduit is 3 ft. deep on curves, and cables are carried around at different elevations, the line of inner rope being 14 ins. and the outer 24 ins. below grade. The horizontal wheels are 32 and 40 ins. in diameter. The first or top wheel has a flat face, against which the grip takes bearing and thereby hinders the inner cable from leaving the grip in case the car is stopped on the curve when the latter rope is in operation. This inner cable rests on or runs against the single groove sheave (represented in drawing) between the top flat-faced wheel and the lower conical wheel, and said conical wheel has a spiral groove for guiding the outer and lower rope (when in use) down to its proper line after the grip has passed. These wheels are placed every 4 ft. on sharp curves, of, say, 40 or 50 ft. radius, and at 8, 12 or 16 ft. where there is less curvature.

The cast-iron riser of the yoke supports the street from the central slot to the concrete wall, a distance of 15 ins. from the inner rail. Cast brackets are placed immediately above the risers aforementioned, and support the cast-iron grating of the street, which extends the length of curve, presenting a uniform surface far superior to the usual paving.

(TO BE CONTINUED.)

Proposed New Terminal Arrangements for Brooklyn Bridge Cable Cars.

We illustrate herewith, in Figs. 1 and 2, the new plan adopted by the Board of Trustees of the Brooklyn bridge, at a brief 40-minute session on May 18, and thereafter made public, and in Fig. 3, the arrangements now existing, with the proposed slight modification to handle 4-car trains instead of 3-car. As we have shown more fully elsewhere, the objections to the newly adopted plan seems so great that it is not at all likely to be constructed, but it at least is for the present the adopted plan for solving a very important and very interesting problem almost wholly new to engineering, and as such we present it.

The circumstances under which the new plan was formed, were these: The growth of travel has emphatically over-grown the capacity of 3-car trains run at 90 second intervals. It is not deemed safe to run trains at closer intervals. To handle longer trains is difficult for lack of switching room at the New York terminus. Four car-trains can be easily enough arranged for, but it is certain that that will afford only temporary relief. According to President HOWELL'S statement, he then called on Mayor HEWITT, who suggested asking Messrs. THOS. C. CLARKE and CHAS. MACDONALD, of the Union Bridge Co., and trustees of the bridge to look into the possibilities of some different system, which was done by letter March 15, 1887. Mr. MACDONALD replied, suggesting the employment of experts, and President HOWELL responded as follows:

BROOKLYN, April 7, 1887.

CHAS. MACDONALD, Esq.:

My Dear Sir.—Your suggestion in relation to the employment of experts to devise proper means of switching four car trains without crossing Center street, I think is worthy of consideration. Our engineers are now at work on plans. At the same time I think we should have the opinion of the very best talent that can be obtained.

You will please proceed at once, and I will request the Board at our next meeting to make the necessary appropriation; having two plans, a much better and satisfactory result will be obtained.

Yours very respectfully,
JAMES HOWELL, President.

In response, Messrs. CLARKE and MACDONALD employed Mr. CHAS. E. EMERY as expert. Eight days later, April 15, Mr. EMERY submitted the plan given herewith with a long report, which we summarize below. A special meeting was called to "consider the plan" for May 18, which, in the words of the Brooklyn *Eagle* (omitting some accompanying repertorial exuberance for which no one should be held responsible)

"Proved one of the most important in the history of that august body. The subject under discussion was a design that had been submitted by Mr. CHARLES E. EMERY, of this city, who had given the bridge officials a plan of easily solving the vexed problem of terminal and traffic facilities for many years to come, no matter how rapidly the number of passengers increases.

"In a few words, when these plans were presented, explained and their completeness developed by Trustee MACDONALD, they speedily adopted them unanimously and ordered President HOWELL to carry them out forthwith. Fourteen trustees were present. J. G. DAVIS, J. A. BUSH, HENRY CLAUSEN, THOS. C. CLARKE, CHAS. MACDONALD, H. K. THURBER, J. VAN SCHAICK, I. WORMSER, S. L. KEENEY, G. W. ANDERSON, A. S. SWAN, Prest. JAMES HOWELL, Mayor D. D. WHITNEY and J. MOLLENHAUER. Superintendent C. C. MARTIN was also present as a spectator."

In presenting Mr. EMERY'S report, Trustee MACDONALD explained that switching four car-trains gave merely temporary relief and the trustees must look to the future, contemplate the ultimate capacity of the structure and act accordingly. He proposed the elevated promenade over the top of the car tracks, as shown in our engraving, instead of the depressed promenade first suggested by Mr. EMERY, saying:

"This plan of the elevated promenade does away with the present system of the promenades passing below the railroad station through a tunnel and finally emerging into daylight on the bridge. But it does more. Four cars must inevitably be used upon the roadways. This space below the station will then be used for a turning place for the train cars and a station for them. Then, when the switching locomotive above is done away with, when double cables and double tracks have driven away the noisy, dirty locomotives, the bridge railroad will be complete and worthy of the structure.

"But there are questions to be seriously considered when about to make such radical changes. One is the flying switch, which must be used until the double cable is in operation. These flying switches are used everywhere in every railroad station in the world and are reasonably safe, but every possibility of an accident will be obviated by the double cable. There are many other details to be worked out before the contracts are let, but when the improvements are completed they will increase the capacity and safety of the railroad and cheapen the cost of transportation."

Mr. THURBER, at the instigation of Mayor WHITNEY, asked what would be the probable cost of this plan?

Mr. MACDONALD confessed that he could not tell, but he did not believe it would cost as much as $50,000.

Treasurer SWAN then suggested the possibility of running two-story cars by raising the top bracing of the trusses. The *Eagle* continues:

"The diversion, however, put everyone in a good humor, and when Mr. KEENEY moved that Mr. EMERY'S plan be adopted almost every one seconded his motion. Before a vote was taken, however, Mr. VANSCHAICK got Mr. KEENEY to accept the following substitute:

"*Resolved*, That the new work and alteration contemplated in the report on terminal facilities just presented to this Board be referred to a committee to consist of Messrs. JAMES HOWELL, THOS. C. CLARKE and CHAS. MACDONALD, with power to immediately proceed with the execution of the same.

"This was carried on roll call, every member present voting in the affirmative.

"Mr. SWAN did not like the personnel of this committee. The present management only had one voice in it, while the advocates of a radical change from the old plans of the present engineer had two in the persons of Messrs. CLARKE and MACDONALD. So he asked that Superintendent MARTIN be added. It was explained that Mr. MARTIN *ex officio* would be the servant of the committee as he now is of the trustees, and that his services would be necessary to the committee in his present capacity of superintendent. The committee remained as suggested by Mr. VAN SCHAICK.

"Mr. MACDONALD suggested that Mr. CHAS. E. EMERY be elected a consulting engineer of the bridge. This suggestion was gladly accepted by the trustees and Mr. EMERY was unanimously elected. Power was give to the committee to fix his salary and the meeting adjourned."

Mr. EMERY is well known to most of our readers as an eminent authority on steam engineering and as the Chief Engineer of the New York Steam Heating Co., where his successful and judicious work has justly brought him great reputation. The main points of his report including some subsequent modifications, are as follows:

22 CORTLANDT STREET, NEW YORK,
April 15, 1887.

Charles Macdonald, Esq., Trustee, etc., New York and Brooklyn Bridge, 18 Broadway, New York:

DEAR SIR—Referring to our interview of the 7th inst. retaining me to present plans in accordance with my views on improved terminal facilities at the New York end of the New York and Brooklyn Bridge, as authorized by JAMES HOWELL Esq., President of the Board of Trustees, and in response to your request of the 12th inst. for me to prepare a brief preliminary statement of my views on the subject, with such illustrative sketches as may be possible while drawings for my consideration are being prepared, I herewith submit the following report:

The subject of terminal facilities of the New York and Brooklyn Bridge in New York involves at the outset a general consideration of the whole system of transportation on the bridge. The experience thus far appears clearly to be that the travel will keep pace with any facilities that may be furnished, and it seems unquestionably best to provide at once to utilize the full capacity of the double tracks now in place over the suspended structure, and at the same time have in mind the necessary steps to be taken, when even the maximum capacity of such tracks is reached, and thus avoid as far as possible a continued series of changes, each successive one involving greater difficulties, and perhaps in the end failing to secure full efficiency on account of embarrassments resulting in a desire to save details of a permanent character already in position.

It is evidently easy to increase the number of cars handled by the present system to four, but then the necessity of five car trains will be as evident as the increase to four is now, and even if it be found possible after due consideration and necessary delay to run five car trains with one starting track it would still be as necessary to do better, so why not arrange at once to run eight or ten car trains upon double starting tracks and independent platforms for incoming and outgoing passengers on the general system already carried out at the ferry terminus of the Brooklyn Elevated Railroad. It needs no argument to prove the practicability of this plan, The incoming trains can be run alternately upon each of the two tracks by gravity, as they are now run upon one track. The trains on the south track can be started out, and run across the bridge by cable as at present, and the north track can be used at once, if constructed, by shifting the alternate trains coming to that track over to the other one by locomotives, as is done with all trains at present, the cars picking up the cable out on the approach as is now done on the Brooklyn side. The writer is prepared to say, however, that it is possible to dispense entirely with locomotives by simply putting in a duplicate cable with which the cars would not only be pulled from the north track to the south track, but hauled entirely over the bridge independently of the other cable, and all the benefits of a duplicate system be obtained. The mechanical details necessary to keep one cable from interfering with the other, and at the same time permit the switching of the cars from the north to the south track entirely by power derived from the cable have all been developed by the writer, and the system, in his opinion, involves no problems of an uncertain nature. It may be added that this opinion has been developed after mature thought, the writer being a resident of Brooklyn, and having made close observations of the construction and operation of the bridge from the beginning.

The changes necessary in the terminal structures to adapt the same for the double starting track referred to are simple in their nature, the difficulties arising mainly from the permanent manner in which the work has been done and the apparent necessity of making the changes in substantially the same way. The increased facilities simply involve minor changes which might momentarily seem serious if considered in detail, but which in the aggregate are of small importance compared with the results which will be obtained. The line of the two parallel tracks now in the station could doubtless be utilized as a portion of the two starting tracks; but some changes of grade both of the track and the footway would be necessary, so that the

switches and crossings of the former would pass over the latter. It is believed that the footwalk can be sunk a number of feet near the station quite readily by cutting out some longitudinal walls and connecting arches which were built to support it longitudinally over the main arches, and this change will probably give as much head room as is required. If, however, it becomes necessary to lower for the width of the footwalk the crowns of a few of the main arches for a short distance, where they carry no load, the cost will be warranted by the necessities of the case. The final result would be that the footwalk would run out on a flatter grade than at present until all switches were passed and then the grade increased until a junction with the present grade was attained out on the approach.

[This part of the plan has since been abandoned in favor of an elevated footway, as shown on our engraving.—ED.]

Within the building the tracks would be used at first as far as they run parallel, when the floor system from that point to the east side of Park Row would need to be rearranged to carry the parallel track out as far as decided. In the opinion of the writer, no attempt should be made to cross either Park Row or Center street. The tracks should stop before reaching the line of the elevated road, the Park Row-Center street bridge widened at that point, and a light building, architecturally one with the elevated station, built at their ends to form practically the upper outgoing station for the trains. The building could be dispensed with, but in any event the ample space provided between the two tracks would be utilized for the outgoing passengers who would always find a train waiting either on the right or left hand side, so that the motion of the crowd would not be stopped and jams be prevented. This space would communicate by several staircases with the floor below. The passages outside the tracks would also connect together on the bridge over the street and in addition with bracketed galleries on the sides to widen the platform, as has now been carried out over the south roadway, or where it is practicable, with staircases outside, which would make a number of communications from the upper platform to the space underneath the building.

In practice, the passengers would enter the cars on one side as they left the other. With the present arrangement of doors it might be necessary to detain the entering passengers until the cars were nearly clear, but the rational system would be to make the cars with very wide doors on the sides at the ends, and when the train entered the station to open only the rear side doors to the outer platform and at the same time the front side doors to the central platform. The incoming would then displace the outgoing passengers, and there would be no confusion, as there would be but one way to get in and another to go out. The absolute time required to get the last passengers out would be greater than it would be with more exits, but when such passenger stepped upon the platform the car would be loaded and ready to start on its return trip.

[Mr. EMERY then makes the following decidedly sweeping claims, the italics in which, are ours: ED.]

It may be claimed that this plan involves so many changes that it would be better to postpone it and apply a temporary remedy. *It is a fact, however, that half of the proposed system would have more capacity than the present arrangement.* By putting in at once the switch to run the cars by gravity from the north to the south track, and leaving room on the latter over the cable for say, five to seven cars, which could be increased to eight or ten when the west end of the station was remodeled, the present inconvenience resulting from crowding would be overcome at once, as the north tracks would be temporarily bridged over near the west end of the building, and the north side of the building immediately used as an entrance, and the south side as an exit before any change of the stairs was attempted. The time between trains would require to be increased a few seconds to keep the incoming and outgoing trains separated as far as is now allowed between an incoming train and the one unloading, *but the increase in the number of cars would from the first greatly overbalance the slightly increased time so that the capacity with only one of the starting points in use would be materially increased even over running four cars by the present system and the gradual remodeling of the station increase the capacity still more.* It would be proposed to put the crossing over the foot walk on a wooden trestle, and in fact change all the inclines and platforms with wooded structures of a temporary character, which would be amply strong and last several years even after the permanent arrangement could be completed. *It is recommended to change to half the double starting point system now if the entire system be never carried out,* and evidently this could be done without an instant's delay to trains.

[Uses for an engine to switch out disabled cars, and for the time being to switch trains across from the north to the south track, using separate tracks alongside the cable-car tracks are then suggested.

It may be claimed that it is unnecessary to make the two starting tracks as long as proposed for the reason that when the double system is fully in operation probably five or at most six car trains would practically do as much work as longer and more unwieldly ones of eight or ten cars. This brings up a very important question. *In driving alongside the bridge cars on a foggy day the writer was impressed with the belief that the present system of running trains at frequent intervals in such weather was unsafe and could not be made safe, as the slightest accident to the running gear requiring a stoppage would generally, before signals could be conveyed by any practical system other than the eye, bring about a collision and in the confusion incident to the same others might follow.* [Italics ours.—ED.] In the opinion of the writer the only proper way to overcome this difficulty is to increase the length of the trains and run them less frequently at such times, so that there will be more time to act in case of an emergency. It is therefore recommended for safety to make the parallel starting tracks at the station long enough to receive eight or ten cars, even if the whole length be not ordinarily needed in good weather.

[No such length is provided for on the plan which we illustrate, however, it will be seen. For the question of its feasibility and utility we must refer to our editorial page.—ED.]

It will appear to some that radical changes of the kind proposed are not as yet warranted, but as stated, the travel will keep pace with the facilities, and it is the opinion of the writer that provision must not only be made to utilize the maximum capacity of the present tracks, but that early consideration should be given to the subject of still greater facilities. These can be practically furnished by laying a single track on each roadway with a flush grooved rail on which cars can be operated at the speed of ordinary light carriage traffic by a cable in the fender at one side, leaving the greater part of the roadway open to slower traffic and permitting carriages to "cut by" between the cars as on street railways. To obtain room for a terminus in New York, these tracks could be made to dip below the surface of Park Row and Center street and the station be located under the City Hall Park; and if desired and the money were available, the cars in Brooklyn could be run underground as far east as the City Hall, or to any other desirable point.

The above will give a fair idea of the views of the writer on the special subject referred to, considered with reference to both present and future requirements.

Very truly yours,
CHARLES E. EMERY.

This proposed underground terminal was abandoned in favor of making the space under the present station an additional cable car station, as noted above. We have discussed the proposed changes, which seem to us extremely inexpedient, on our editorial page.

On the Necessity of Standard Conditions in the Application of Wanklyn's Method of Water Analysis*

BY A. A. BRENEMAN, S. B.

The process of water analysis for sanitary purposes, which is commonly known as Wanklyn's method, is still, notwithstanding its admitted imperfections, more commonly used, in English-speaking countries at least, than any other. There is no process of this class which can take its place, and the question of water supply in its sanitary aspects is probably better understood to-day than it could have been without this process. As there is no immediate prospect of a better method, it is desirable that every effort should be made to eliminate its known errors and to so prescribe the conditions of its application that the results obtained by different chemists may be comparable.

By the essential principle of the process organic matter, in alkaline solution, is oxidized by a reagent which constantly varies in strength, and consequently in the temperature at which it acts. If these elements of variation are not the same in successive operations, the results are not strictly comparable. The nature of the organic matter concerned and its susceptibility to oxidation may differ widely in different analysis, and with this difference every condition of concentration, temperature, etc., will vary in its effect, that is, in the respect to the quantity of ammonia disengaged in a given time, in a given number of distillates or from a given volume of liquid.

The standards fixed by Wanklyn for interpretation of the results of an analysis are valueless unless all conditions of the analysis be uniform in successive operations. To leave all questions of interpretation and manipulation as well, to the judgment of the chemist concerned involves so large a personal equation that it may be questioned whether, in such a case, any basis for comparison of results will remain. Decision as to the relative significance of a given quantity of albuminoid ammonia must often be left to the chemist who is familiar with the circumstances under which the water was taken; but the condition of the analysis should be so clearly defined that no room shall be left for variation in the essential features of the analytical work.

The possible errors of the Wanklyn method relate principally to the rate at which the distillation is conducted and to condensation of the distillate. The general question of loss of ammonia by imperfect condensation, has been quite fully investigated by Dr. SMART (Rep. National [U.S.] Board of Health, 1882). He has also given a few instances in which the time occupied in the collection of each distillate was noted. The writer has reported in a previous paper (this Journal, Vol. VIII., No. 1) a large number of analysis in which the time occupied in collecting each distillate was observed, and he has also called attention to the importance of this feature of the method, and suggested a definite rate as most suitable under the conditions given.

The process as described by Wanklyn takes no account at all of the rate of distillation, and the process is said to be complete when three distillates have been taken off to represent albuminoid ammonia (Wanklyn's Water analysis, Sixth Edition, p. 40†). The extent to which the distillation is carried is also a matter which should be fixed, since it may happen in the case of dilute solutions that the ammonia evolved sinks below an appreciable amount and then rises again as increased concentration of permanganate and alkali causes more rapid evolution of ammonia.

The loss of ammonia by imperfect condensation which SMART has shown (Rep. Nat. Board of Health, 1882, p. 251) to average 7.2% in twenty-five experiments, depends both upon time or rate of distillation and temperature of the condenser. It will also depend, although in lesser degree, upon the relative volume of retort and condenser. The loss of ammonia is insignificant when the steam is thoroughly condensed and perfect collection of ammonia requires only a relative abundance of water at a temperature sufficiently low to retain it in solution.

With respect to the possible escape of nitrogen in the form of volatile organic bases, slow distillation offers the best security against such loss by retaining these substances longer in contact with the reagent which will ultimately set free all of the nitrogen which they contain to form ammonia.

The rate of boiling, or the time occupied in distilling a given quantity of water, being so important, there can be no conformity in results unless some prescribed rate be fixed upon for general use in this process. The writer has found that the rate of ten minutes for each portion of the distillate, when 100 c.c. are taken for analysis, is easily maintained and gives in the aggregate a higher proportionate yield of ammonia than a rate which is somewhat slower. In other words, the yield of albuminoid ammonia does not continue to increase with time of distillation as rapidly above this rate as below it. This limit is found to answer well for many different waters. When 500 c.c. are taken for analysis, and 50 c.c. of distillate collected for each test, the corresponding time is twenty minutes. That the smaller volume should take less time for the evolution of a given proportion of the whole quantity of ammonia contained in it is probably to be explained by the fact that both heating surface of the retort and free surface of the liquid are greater in proportion to volume in the smaller liquid, and these conditions favor, in the latter, the disengagement of ammonia.

The volume of liquid in the retort at the beginning of the analysis, and also when the distillation of albuminoid ammonia is begun, should be the same for the corresponding stages in all analysis; if not, the degree of concentration of the permanganate will be different, and the results will not be comparable. Such discrepancies are largely corrected, it is true, when the distillation is carried nearly to dryness as hereafter directed, but the fact that a larger number of distillates is taken increases, on the other hand, the chance of loss of ammonia by imperfect condensation.

The end of the distillation, or the point at which the collection of albuminoid ammonia is to be stopped, should also be prescribed. The writer prefers the point of approximate dryness as the uniform stopping point in all analysis, and by this is meant the point at which the residue in the retort is reduced to less than the volume of one distillate as measured by the Nessler tubes in use. It is quite safe, either as regards spurting of the liquid or fracture of the retort, to run the liquid down to 5–7 c.c. when 100 c.c. are used, or to 20–35 c.c. when 500 c.c. are taken for analysis, provided that the flame is turned down as the volume of liquid is reduced, and this is necessary at any rate in regulating the time of distillation as above mentioned. Each sample is thus submitted for a long time to the action of the slowly concentrating reagent, and is violently attacked at the last by the same in its strongest and hottest condition. Experience shows that there is always an increased evolution of ammonia at the last with waters that retain any organic matter at all up to this point. To carry the operation further by filling up the retort with ammonia-free distilled water is tedious, and for many reasons impracticable, and it is questionable whether any conclusion

*From "The Journal of the American Chemical Society," Vol VIII, No. 2.

†Subsequently (p. 50), in describing the 100 c.c. method (as a possible substitute for the method using 500 c.c.), he directs that in this case the distillates shall be collected as long as any ammonia can be found in them.

can be reached in this way that will permit a closer comparison of waters as to their organic pollution than by the method just given. The quantity of ammonia obtained at each successive refilling is generally very small, and many repetitions may be necessary. Small and frequent additions only can give to the organic matter present a repetition of the conditions obtained at the close of the first distillation, that is, heat and high concentration of the reagent, as all weaker attacks have already been successfully resisted by this matter. Repeated operations also involve, from several sources, an accumulation of small errors, which tends in time to counterbalance the increased accuracy which they aim to secure. The limit of distillation above suggested is a simple and practicable one, it involves no break in the regular course of the distillation, and offers, it is believed, the best approach to uniformity of treatment for all samples of water.

One other point which is closely connected with the foregoing should be fixed as a condition of the process, namely, the preliminary distillation by which the retort is freed from ammonia. Wanklyn's direction to use ordinary water, distilling with alkaline permanganate and then rinsing the retort before introducing the sample, is tedious and unnecessary besides involving much handling of a hot retort. The writer has long used the following method of manipulation which is free from the objections mentioned and has the advantage of being uniform and precise.

The retort is rinsed with strong HCl and a fragment of sodium hyposulphite to remove the residue of a previous analysis (or boiled with a mixture of bichromate and sulphuric acid if it be a new retort, or one previously used for any other purpose) washed, and rinsed with distilled water. The drawn out neck of the retort enters the tube of the condenser to a depth of at least 2 in., and a wide rubber tube, which remains stationary on the condenser, closes the junction as the retort is put in place. A stout ring of rubber (umbrella ring), which slips over the rubber tube, is used to secure the latter upon the neck of the retort when it becomes loose through use. Into the retort are put a few grains of previously ignited pumice,* 2 c.c. of a saturated solution of fused sodium carbonate and 100 c.c. of ordinary distilled water. 85 c.c. are distilled off rapidly into a flask holding that volume to a mark on the neck, and 10 c.c. into a Nessler tube, the latter being tested for ammonia. The residue in the retort should then be from 4 to 7 c.c. This preliminary operation furnishes, incidentally, a good test of the condensation. The retort being shown to be free from ammonia, 100 c.c. of the water to be tested is introduced and distilled to approximate dryness under the conditions hereafter given. The possible objection to the procedure just given is that the residue of the distilled water may contribute something to disturb the result. As to this it is plain that free ammonia is out of the question and the absence of albumoid ammonia can be shown by an occasional analysis in blank, remembering in this case that any trace of albuminoid ammonia obtained represents twice what would occur in an analysis, as two portions of 100 c.c. each will be used, in practice, if distilled water be free from sediment and dust, no disturbance of the analysis is to be feared from this source. The above directions apply to the use of 100 c.c. for analysis. If the older, or 500 c.c. method, be preferred the quantities are proportionally increased except that 200 c.c. of water suffice for the preliminary operation.

The use of 100 c.c. instead of 500 c.c. was recommended by Wanklyn long ago and the same directions appear in later editions of his water analysis. It is much to be regretted that its use has not become general to the exclusion of the older (500 c.c.) method. It is at once more simple, more accurate and more economical of time and material than the latter. It is evident that the estimation of a given weight of ammonia by the Nessler test in a column of liquid 10 c.m. in depth for a volume of 10 c.c. must be more accurate than the estimation of five times that weight in a column of 15 c.m. in depth for a volume of 50 c.c. In practice it is less difficult to detect .0005 of ammonia in a 10 c.c. tube than .005 of ammonia in a 50 c.c. tube. The smaller tubes, moreover, are more convenient to handle, less liable to break and far less costly. Not the least advantage of the 100 c.c. method is the saving which it effects in the use of that peculiar reagent—troublesome to prepare and difficult to keep—ammonia-free water. The testimony of chemists who have tried both methods is entirely in favor of the smaller volume. The writer has used the 100 c.c. method in more than five hundred analyses.

With regard to the plan of distilling to approximate dryness in the determination of albuminoid ammonia, it may be asked whether results obtained in this way are in any sense comparable with those obtained by following Wanklyn's directions. These directions, as has already been said, are misleading so far as the 500 c.c. method is concerned, and results obtained by them will not be comparable among themselves. To distil to the point at which the evolution of ammonia appears to cease, may also be misleading in some cases, unless that point corresponds with great reduction of volume of liquid in the retort. The proposed method yields results which compare much better among themselves, and quite as well well with the latter in general, as these latter compare with one another. The writer has found from a study of twenty-four analyses that the yield of albuminoid ammonia (from Croton water) between the third distillate and the point of approximate dryness was, on an average, one-third of that yielded in the first three distillates. The required correction would be much less than this amount where the distillation was carried to entire disappearance of ammonia, as is commonly done. The modifications of the Wanklyn process suggested above may be summarized in the following plan, by which it is believed that many of the uncertainties of that process may be eliminated.

1st. Into a glass stoppered half litre retort put 100 c.c. of distilled water, 2 c.c. of saturated solution of fused sodium carbonate and a few fragments of previously ignited pumice. Distil off rapidly 85 c.c. into a flask, and reject; collect the following 10 c.c. and nesslerize.

2nd. Add 100 c.c. of the water to be tested, collect 4 portions of 10 c.c. each for free ammonia and nesslerize each. Each distillate should be allowed ten minutes to collect.

3rd. Put 11 c.c. of alkaline permanganate† solution into a small beaker, having a file mark on its side, representing 16 c.c.., and another mark for 11 c.c. Add ammonia-free water to the upper mark, and boil down to the lower mark; then transfer the hot liquid through a long-necked funnel to the retort. Distil off 7 portions, allowing ten minutes for each distillate, and lowering the flame occasionally as the volume of liquid is reduced. The operation is then finished, and 4-7 c.c. should remain in the retort.

The weak standard solution of ammonia and the Nessler reagent are delivered respectively from glass stoppered burrettes, one measuring to $\frac{1}{10}$ (.05) c.c. the other to $\frac{1}{2}$ c. c.

The directions apply equally well to the 500 c.c. method except, as already stated, that 200 c.c. only of water are used for the preliminary distillation, and that twenty minutes instead of ten are given to the collection of each distillate.

*This pumice is prepared in quantity by breaking it, and sorting to a size of $\frac{1}{4}$ inch, free from dust. It is ignited for ten minutes at a red heat, in a platinum dish, and kept in a tightly stoppered, wide mouth bottle.

†The alkaline permanganate solution is made with ordinary distilled water, and is boiled down in preparation from 1,500 c.c. to one litre, 500 c.c. of water in excess being added at first. The volume of 11 c.c. is used in order that 1 c c. may be allowed for drainage, etc. The volume quickly delivered into the retort is then little over 10 c c. This portion is prepared during the collection of free ammonia, and the distillation is only interrupted for a moment in introducing it.

The Effects of Magnesia in Portland Cement.

BY HENRY FAIJA, M. I. C. E.

The attention of engineers and users of cement has lately been drawn to the effects produced in cement by the presence of magnesia. Many have spoken and written about it until magnesia has become the *bête noir* of all users of cement. Some engineers specify that the cement they use shall contain no magnesia, though some are courageous enough to admit 1 per cent. It is curious that only a few years ago the greater excellence of the German cement over the English was thought to be due to the presence therein of a larger percentage of magnesia, and many German cements give an analysis of as much as 3 per cent. Now, of course, it is not admitted that the German cements are better than the English, and the magnesia instead of being the one thing of all others which made the cement, is tabooed altogether. It is to be presumed, therefore, that there is a fashion in the components of a cement as there is in a lady's dress and that which is *en règle* to-day is *gauche* to-morrow.

No doubt if magnesia enters largely into the composition of a cement it produces one that is dangerous to use, but so does an excess of lime, or even a properly limed cement not having that lime wholly, or nearly wholly, in the form of a silicate is equally, unsound; but the difference between one, two, or three per cent. of magnesia, or of one, two, or three per cent. of unsilicated lime, is as nothing compared to many other matters of composition and manufacture which tend to produce a good or a bad cement. While, therefore, a small percentage of magnesia is not harmful to a cement, to make a cement from a dolomite or magnesia limestone would be courting failure, and nobody with any knowledge of the manufacture would attempt it. These limestones produce some of the strongest building limes, but as an item in cement manufacture they are useless

Magnesia is dangerous in a cement for the same reason that lime is, viz., that when in its free state, it, on the addition of water, expands, and of necessity if there is a large quantity present it will destroy the work of which it forms a part, and magnesia in a cement must be more or less in a free state, because carbonate of lime and carbonate of magnesia on calcination loose their carbonic acid and amalgamate with the silicas and aluminas with which they are mixed in the formation of a cement at different temperatures and after different intervals.

There is an old proverb which reminds one that it is impossible to make a silk purse out of a sow's ear; neither is it possible to manufacture magnesia in a cement kiln—it must be in the raw materials of which the cement is made; and but few, if any, of the cements made in England are made from raw materials which contain any appreciable or abnormal quantity of magnesia. Most English cements will be found to contain from one to two per cent. of magnesia, and there is no doubt that that amount is well within the margin of safety. The mistakes made with cement are not in its manufacture so much as in its use; the practice of using cement direct out of the sacks is the cause of ninety-nine per cent. of the failures which occur in concrete work. If the cement was only turned out of the sacks for a week or two on to a clean dry floor, the particles in it of free lime or of free magnesia would became inert, and blowing cement would be unknown.

It is doubtful if the user is justified, or even wise in his own interests, to enter into the manufacturer's art—enough for him if he knows whether the cement is sound or unsound—it is for the manufacturer to determine the cause of failure and remedy and amend his manufacture in accordance with his experience. The art and science of manufacturing cement is not to be learned in the time which an engineer or architect in large practice has to devote to it. The knowledge of the chemical components of a cement is but a small part of the matter; a perfectly proportioned cement, so far as can be determined by analysis, may be an absolutely dangerous one to use; whilst, on the other hand, a comparatively poor cement by analysis may be a perfectly sound cement and a safe one to use. There are several known methods of determining whether a cement is sound, and any one of these in conjunction with the test or fineness and tensile strength, will give a better general knowledge of the properties and capabilities of the cement than it is possible to obtain by analysis. An analysis is always useful as a corroborative test, as it may explain the cause of any peculiarity noticed during the mechanical examination of the sample, and a carefully carried out analysis is therefore in many instances of very great value in assisting in the determination of the quality of a sample, but a cement should never be bought on analysis only.—*The Engineer.*

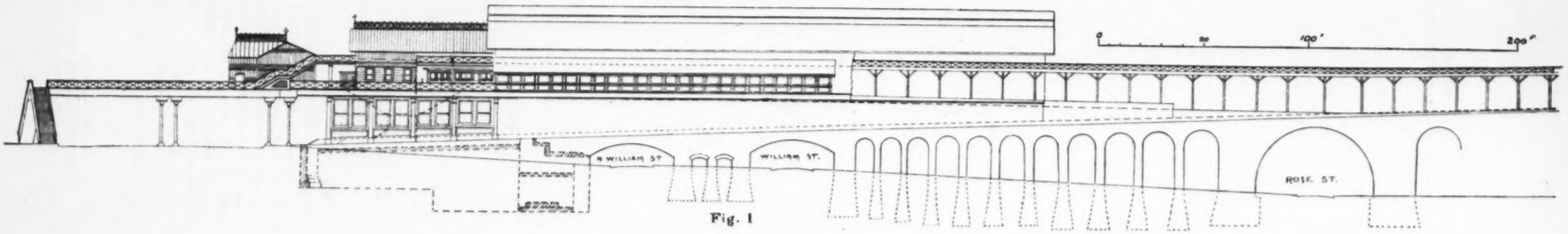

Fig. 1

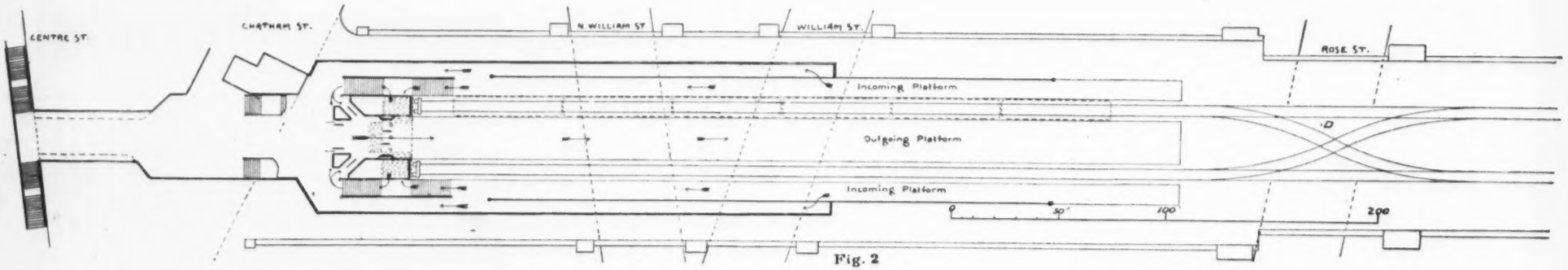

Fig. 2

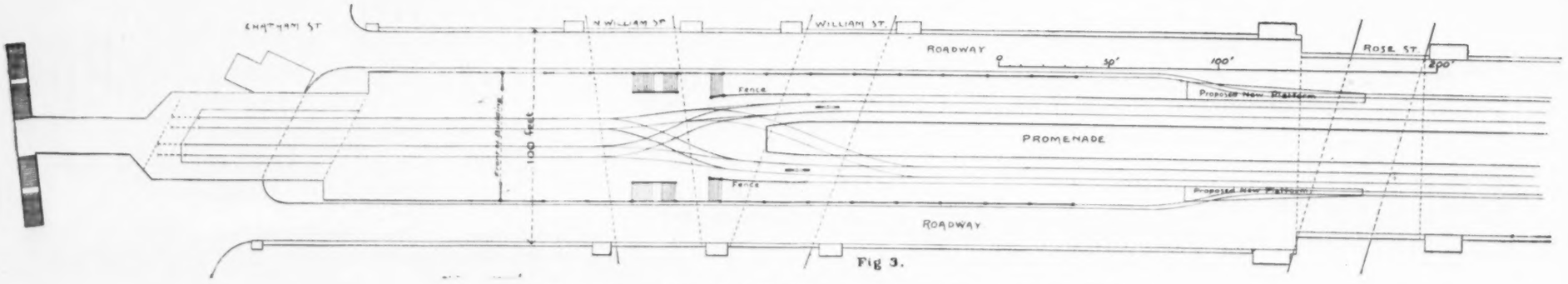

Fig 3.

The Proposed and Present Terminal Facilities of the Brooklyn Bridge (See Page 360).

Figs. 1 and 2 show by Elevation and Plan the proposed system, as recommended by CHARLES E. EMERY, Consulting Engineer, and adopted by the Board of Trustees, May 18, 1887. The chief changes besides the changes in the cable car tracks are: 1. The present promenade which follows the grade of the roadway (Fig. 1) and sinks below the cable-car tracks at the entrance, is raised upon an elevated trestle-work of wood or iron above the cable-car tracks, with an additional stairway near the Manhattan Elevated Railway station, which is the small building at the left. 2. A prolongation of the present terminal building is added. 3. The present terminal building is widened on both sides, by bracketed extensions projected over the roadway. 4. The present bridge to Centre street is widened somewhat.

Fig. 3 shows the present arrangement of tracks, as it now exists, except for the cross-over to the right across the top of the promenade, which it is proposed to add in order to be able to switch four-car trains during the busy hours. The north platform opposite the promenade is the unloading platform, and the cars are then switched across to the south or loading platform.

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D. McN. STAUFFER. A. M. WELLINGTON. EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

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WE regret to see by the Boston press reports and private information that the meter test is still progressing in a manner that is unsatisfactory, to say the least, to many who are vitally interested in the final value of the report. We regret this the more because, contrary to a very generally expressed opinion and to our own original suspicions, founded upon past methods, the test proves to be intended for a thoroughly impartial trial of the relative merits of the competing meters. In fact the names and professional standing of two of the three commissioners are a sufficient warrant that no inside deal would be permitted were such intended by a local meter-ring. One of these gentlemen is Mr. L. FREDERICK RICE, President of the Boston Society of Civil Engineers, and another is Mr CHARLES CARR, a consulting mechanical engineer of high repute and formerly vice-president of the Boston Machine Co.; the third commissioner is also an engineer of reputation as far as we can learn.

While these gentlemen can in no manner be connected with any such peculiar methods as characterised the adoption of the Tremont meter some years ago, we can not help repeating that they seem to be doing themselves an injury by the exercise of over-caution in their strict prohibition of public inspection of the details of this trial. They occupy a peculiar and not entirely enviable position, and should omit no precaution that would tend to make their test thorough, exhaustive and impartial, and more important still, to have their final report received by the public unimpaired by any conditions that could be used to cast a shadow of doubt upon the correctness of the methods pursued. Common rumor is far from complimentary in regard to these methods; but if they have been misrepresented it is directly chargeable to the fact that all outside report has been based upon a partial and very imperfect examination of the workings of the various competing meters. The present trial is one of great interest and should be of great value, and we earnestly trust that the golden opportunity will neither be lost nor its value impaired by unfounded mistrust.

IN a word every competitive test of a mechanical device involving heavy pecuniary interests pre-eminently demands that the trial should be made in the most open manner, with every step taken and every condition of trial laid bare to the public. The sole purpose of such a test is to expose the faults and make plain the merits of a device without regard to the personal feelings or interests of an inventor. Here the public alone is to be served, and unless the methods are known and opportunity given for the fullest criticism there will always be room for insinuation as to the honesty of the trial, the competency of the experts or the inside manipulation of interested and unscrupulous parties. In such matters the public will seldom accept the unsupported decision of a board of experts, no matter how high the personal standing or professional knowledge of such experts; evidence and details are demanded before the verdict will be adopted and pass unchallenged. And just here we might remark that, according to the programme announced, the coming trial of car-couplers is to be conducted somewhat after this same secret and very unpopular manner. This is a mistake in our judgment and will be likely to insure a repetition of the unfortunate series of comments and charges that threaten to mar the value of the Boston tests. We are glad to learn at the last minute that this action has been reconsidered.

THE startling project for a grand new air-line trunk line between New York and Boston, which is announced on our news page, bears a striking and painful similarity in its general features to the great West Shore project, which we hope is even yet not so old that its lesson has been forgotten, should the projectors of this line actually succeed in getting their project under way, which is not impossible. There has been for many years a great deal of talk of such a line and more or less "work" done on it, but it seems to be nearer to materialization now than it has ever been before, to say the least.

The total estimated cost of $23,000,000 or $125,000 per mile seems at first sight enormous, but it may be questioned if it is sufficient to carry through such a project. The capital stock of the New York, New Haven & Hartford (123 miles) is $15,000,000 with $2,000,000 more of bonds. Springfield divides the Boston & Albany into two nearly equal parts, and half its stock amounts to $10,000,000 with $5,500,000 more of bonds. This all aggregates $33,000,000 for the New York-Boston line, while the New York & New England has a little more yet.

The enormous actual and potential traffic between New York and Boston makes it more than usually probable that a line built merely to connect those two cities, *and connecting them better than any other line*, especially as to its terminals, might prove a financial success, but as a rule, the cause of the failure of all such lines is that they do not correctly weigh the enormous advantages of striking a good sized city every 40 or 50 miles. The proposed line is projected to run through New Haven, but any line which fails to strike either Worcester and Providence in addition, will be handicapping itself to an extent which the sanguine projector is not apt to realize until too late.

OUR surmise last week that *The Engineer's* assertions as to the immunity of English bridges from accident were wholly unwarranted by facts has been very promptly confirmed by a correspondent, who writes us:

"In the matter of English bridge accidents, and your remarks thereon in ENGINEERING NEWS of May 28, I have details of a number of such accidents which I will be pleased to send you in a few days, as soon as I can make explanatory drawings; as also a few samples of English bridges in Australia, designed by English engineers of the highest rank, the like of which would I think (and hope) be hard to find in this country."

Pending the publication of these facts, we suggest to *The Engineer* that it make a little investigation on its own account—having made its assertions—and make the proper correction of its own free will since we have no doubt that it is as cheerfully ready to expose faults of English practice as it is of American,—if it could only once see evidence that there were any.

WE published in our issue of May 21, an utterly absurd statement from a daily paper as to the westerly rails wearing out more quickly on north and south lines because of the revolution of the earth, etc., etc., prefacing it by the remarks that it was "a contribution to science which ought to be better known to engineers than, according to the best of our information and belief, it is." The statement was so entirely absurd that it never occurred to us that any one from the select class which subscribes to ENGINEERING NEWS could suppose that it was quoted for any other purpose than ridicule.

We are gradually learning, however, that no statement, however absurd, can be safely made or quoted for such a purpose unless it is labelled *a la* Artemas Ward, "N. B.—This is a goak." For along comes a letter in due course of mail from one of the great cities of the booming west, stating that "in your issue of May 21 appears a statement," etc., and "the supposed phenomenon is explained," etc., after which our correspondent (one of our most respected subscribers) proceeds to knock down at some length the straw man which he has set up, pointing out that the alleged phenomenon is not possible. He then adds:

"There would, however, be a slightly greater pressure on the easterly rails for trains moving away from the equator, and on the westerly rails for trains moving towards the equator, due to the change in the actual speed of the surface of the earth for the change in latitude.

"The total result for single track roads would of course be *nil*, and for traffic continually in the same direction, I cannot believe that the effect would be appreciable from this cause."

To fall back again upon ARTEMAS WARD, "Alas, too troo." We agree with our correspondent that there is no reasonable chance for anyone to indulge in mathematical gymnastics with this problem to any possible advantage. Hereafter, we will label as such the "goaks" which we quote, as well as any which we may dare to try to make.

THERE is to be no mistake this time about the new "tin bridge," work on which we are informed has begun. Instead of having one of the greatest skews on record the new bridge is to have none, and instead of being a wretched iron one it is to be a solid stone one, and the massive and imperishable abutments which have stood uninjured for nearly 50 years, and are good to stand for 100 years more, are to suffer vicariously for the sins of the bridge they carried.

"For poor human nature a pendulum seems
That must constantly vibrate between two extremes."

There will be no great harm done, and yet it seems almost a pity, for half the money that the new stone arch will cost, would build a solid plate girder with a buckle-plate floor and stone ballast on top of it which would be to all intents and purposes as solid and as safe as an earth embankment, while it would leave the beautiful road which now passes under the bridge undisfigured. There have been a number of instances in which bad iron bridges have been replaced by stone in this way, and while a fine stone arch is a beautiful thing to look at, we regret to see them built at such times and for such reasons, for it amounts to a confession of what is not the truth, that for real true solidity we must revert to stone. As a matter of fact, an iron structure with anything like the same surplus of strength as a stone one, is if anything, a more durable structure,

quite as safe, and much cheaper. But the engineer who should attempt to figure the strains in a stone structure down to a pound, and then work to them, would be laughed at, while the man who figures iron bridge strains in that way—unfortunately—is not. Hence the delusive apparent contrast in stability.

A PROMINENT railroad officer who writes us thanking us for our "recent full exposition of the status of the LATIMER safety-guard patents" which he is now testing preparatory to adoption on all his bridges adds:

"We have by the way, been using for about 12 years past, guard rails on our bridges curving the rails to a point in the center of the track just outside the abutment, where a cast iron block is placed, at the toe, to prevent brake-beams, etc., catching against the guard rails. This has on several occasions helped to carry a derailed pair of wheels, or a truck, over the bridge without slewing; but we have had no re railing device like LATIMER'S."

Such experiences well show the immense advantage of well-designed rerailing frogs in the crotches of such guard-rails, for it has been again and again shown that if the truck is not so displaced as to miss the point of the bevelled rails entirely, the rerailing frogs will infallibly put the wheels back upon the track uninjured. We are satisfied from the careful inquiries which we have made, that there is not a single instance on record where it has failed to do so, while the only cost of this great safeguard is a few hundred pounds of cast-iron. By no other device, we think, can so great an addition to safety be made at so small a cost.

COPIES to fill the advance orders for Wellington's "Economic Theory of the Location of Railways," will be sent out this week. There was some further unavoidable delay in binding the volumes, so that we have not been able to do this before, and as there are nearly one thousand of such orders, many of them of several months' standing, there have probably been some changes of address of which we have not been advised. Subscribers are therefore requested to send in their correct address at once, if there has been any change. *It will not be sufficient* that they should have changed the address of their paper, since the two records are distinct. Hereafter we shall be able to fill all orders immediately on receipt.

THE pressure on our space this week is so great that we are compelled to postpone further report of the Burlington brake tests to another issue. Some very fine stops were made; the Westinghouse brake beat the record on 50 empty car stops, and the Carpenter on 50 mixed loaded and empty car stops; but it must always be remembered that "the record" is by no means the only thing to be considered. Suits for infringement have been entered by the Westinghouse Brake Co. against Mr. CARPENTER.

The Brooklyn Bridge Problem.

We fear that the Brooklyn Bridge trustees have acted in haste only to repent at leisure in regard to the proposed new plan for a radical change in their cable car system which we present elsewhere. The problem is practically a new one to engineering, for nothing exactly like it has ever arisen before, so that it is excusable for anyone to make a mistake in it, and recognizing no infallibility in others we claim none for ourselves. Nevertheless, the proposed new plan is open to so many and such serious objections that we cannot but wonder that the trustees should have acted with such unusual, not to say improper haste, without even the pretense of previous discussion or investigation.

The difficulties which appear to exist in this new plan are very radical, and briefly these:

1. It does not in fact increase the capacity of the bridge in the slightest over what is immediately attainable by the present methods, with one or two trifling modifications and at merely nominal cost.

2. It involves elements of danger which should in no case be tolerated, while other possibilities remain, even if the increase of capacity were as great as supposed.

3. It does not by any means reach or approach the ultimate capacity which is attainable in other ways at less cost.

4. The proposed appropriation of the carriage-ways for cable car purposes, when those carriage-ways are likely to prove far too small even for their original purpose when turned into public highways, as they must be in time, is both improper and unnecessary.

To establish these four propositions clearly, as we think we can, we must take some space.

The conditions of the problem are briefly these:

1. An enormously costly structure (nearly $14,000,000) is located just at the point where it best serves the end of connecting two great and rapidly growing cities. To relieve the pressure of traffic by duplicating the structure is practically impossible, except in its immediate vicinity, as a glance at the map published in our issue of May 14 will show. A bridge farther to the north would not take the traffic where it wants to go. The river widens to the south and affords no favorable site. To build a duplicate structure in the immediate vicinity would be a ridiculous confession of weakness until the utmost has been done which can be done with the present structure, and the enormous cost forbids even a thought of such a policy while any other resource remains.

2. A practically unlimited stream of travel only awaits opportunity to flow over the bridge. The growth of traffic in the four years since the bridge was opened has been enormous, as follows:

	1883	1884	1885	1886
Total pass'rs., thousands,	5,440	8,491	17,023	24,029
Increase per year,		3,051	8,532	7,006

If anything may be predicted with certainty it is that the natural growth of population, the increase of Brooklyn facilities for reaching the bridge, and other causes will, in a few years, multiply many fold the existing traffic, if convenient facilities for it exist. This is especially certain if we remember that the traffic is not evenly distributed between the twenty-four hours, but more than half of it each way is done in 3 hours out of the 24, and about one-quarter of it in 1 hour of the 24. This is shown in an interesting way by a diagram which we published Jan. 31, 1885, from which we extract the following figures of the traffic on Dec. 20, 1884, which up to that time was one of the heaviest days:

Passengers in Brooklyn Bridge Cars, by Hours.

Brooklyn to New York.			New York to Brooklyn.		
7 to 8 A. M.	3,030	16.4 p. c.	4 to 5 P. M.	2,240	16.6 p. c.
8 to 9 "	4,020	21.8 "	5 to 6 "	3,486	25.7 "
9 to 10 "	2,380	13.0 "	6 to 7 "	1,650	12.2 "
Total 3 hours	9,430	51.2 p. c.		7,370	54.5 p. c.
Remain' 21 h.	8,970	48.8 "		6,160	45.5 "
Total 24 hrs.	18,400	100.0 p. c.		13,530	100.0 p. c.

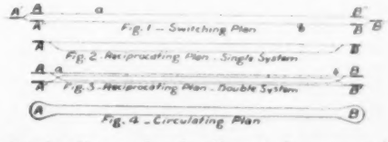
At present, three or four times this number is not considered a very heavy total, but its distribution is about the same.

3. The trains are to be danced back and forth like a shuttle-cock without intermediate stops, over a very short distance of 5,989 ft. (1.13 miles). Every 600 ft. of haul lost, therefore, is 10 per cent. off the value of the service. The character of the service, as well as the heavy up-grade (3½ per cent.) makes the cable system seem most suitable, and it is actually in use. A very small horse-power (35 to 50 H. P.) now suffices, and power for many times the present service could be readily furnished, while the bridge is strong enough to transport millions daily, unless in some correctable minor details. If the bridge is worth its cost for handling its present traffic (and no one disputes it) anything which will double its present traffic at a cost of 1 or 10 per cent. of $14,000,000 will leave 90 or 99 per cent. of $14,000,000 as a net profit from the operation. The question of expense therefore hardly enters into the question. The only pressing difficulty is in handling the cable car traffic.

Three different plans, and so far as we can see only three, are possible for handling the cable car trains:

First: *The switching plan*, shown in Fig. 1, which is that now in use. Under this plan *A* and *B* are the receiving platforms. The empty train is then switched to *A'* and back to *A''*, where it is loaded and goes out again. While one train is unloading another train is switching on *A'* and still another is loading or just starting out from *A''*. The limit to capacity, therefore, is the number of trains which can be unloaded at *A*. In practice, the grip is released at *a* and *b* at a point some 500 ft. back of the unloading platform, and the heavy down grade gives a somewhat accelerated velocity which carries the train to the unloading platform and saves a part of the otherwise lost time for stopping. In starting trains about 150 ft. of cable slips through the grip before the train is fully under way, corresponding to a loss of 10 seconds of time. The speed of the cable is 10 miles per hour, or 14.67 ft. per second. The chief objection to this plan is the great amount of switching room needed beyond the terminus proper.

Secondly: *The reciprocating plan* proposed by Mr. EMERY, and shown in Figs. 2 and 3. In its simplest form, Fig. 2, the train is simply switched in and switched out again at *A* and *B*,



after loading and unloading at the same point. The plan proposed, Fig. 3, is simply a duplication of Fig. 2, alternating the trains on each system so that the same roadway may be used by each between *a* and *b*.

Thirdly: *The continuous circulation plan*, Fig. 4, in which the trains are continually in motion on an endless track, stopping only to load and unload at each end.

It will be seen at once that the first and third plans have a certain general similarity to each other, differing only in the manner of shifting the trains from the incoming to the out going track. In each case the trains approach each other only from the rear, and the limit of capacity is the number of trains that can be unloaded at *A*. Plan 2 is in broad contrast with them, in that the trains run in and run out again in the face of the next approaching train. We may say at once that the third plan strikes us as the only one worthy of serious consideration, when the possibilities of the present system have been exhausted, which is not yet. Its advantages over any other possible system are many; the apparent difficulties and objections largely imaginary. But before considering that plan in any way we will first consider the comparative merits of the first and

second, or the present and recently adopted plans.

Under the present system, Fig. 1, the interval between 3-car trains is 90 seconds, or 1,320 ft. on the cable. This time is divided up about as follows:

Stopping train from 10 miles per hour	10 sec.
Unloading train	45 "
Margin of time for security and irregularity of trains, to get the empty train out of the way	35 "
Total between trains	90 "

It will be seen that the necessary interval between trains is one of *time* rather than of distance. A higher cable speed of, say 15 miles per hour would not increase the capacity of the bridge, but only save the passengers two minutes each of time. The 45 seconds for unloading seems to be a constant determined by experience to be none too large for getting all the lame, the lazy, the young, the old, the drunken and the quarrelsome out of the car, although 20 to 30 seconds often suffices. It is plainly improper to cut this time too short even if it is *ordinarily* possible. The 10 seconds for stopping is ordinarily less, because something is gained in time, by dropping the cable on the grade and

Fig. 5

running in by gravity, but it is the same allowance as is found necessary for starting. The 35 seconds for "lee-way" is also found none too great, for if the switch-engine fails to couple at the first attempt, after unloading, it is even now found necessary to flag the approaching train, and quite a number of trifling tail collisions have happened, we believe, although no one has been injured by them.

The worst collision which can happen is between a loaded moving train and empty stationary train. All velocity which the empty train may have acquired in being switched off, or the loaded train lost by the brakes in approaching its stopping place *according to the usual routine*, is so much off the force of the collision, which is hence not likely to be at more than 5 or 6 miles per hour. A collision at this speed on a straight track is not a very serious matter to contemplate at the worst, especially as *neither train is gripping the cable*. Yet for this danger 35 seconds is allowed.

Let us turn now to the other plan, which it is proposed to adopt. We will consider it in its simplest form, Fig. 5. What must be done is, for an incoming train with its head at *I* to

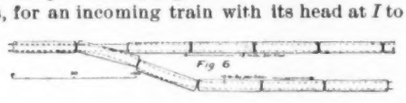


Fig 6

go into the station, unload and load, get under way again and clear the danger-point *D* by having its rear at *O* before the head of the next following train reaches *I*. What time is necessary for this? There must of course be at least as great margin of time for safety as by the other plan, and we have the following contrast:

Lost time stopping train, as above	10 sec.
Unloading train, as above	45 "
Margin of time for irregularity of trains, as above	35 "
Total of common items	90 "
ADDITIONAL ITEMS.	
Extra time for loading and unloading at the same time, say one-third more than for unloading only	15 sec.
Lost time starting train (150 ft. of cable)	10 "
Time required for train to run from *f* to *E* and back again from *E* to *O*, at cable speed of 3.4 seconds per car-length = (no. cars + 2) × 2 × 3.4, = for 6 car train 16 × 3.4 =	54.4 "
Total of unavoidable *extra* time per trip	79.4 "

Every additional car in the train increases this necessary time by nearly 7 seconds.

Thus it will be seen that under the best possible showing the time needed for handling trains in this way amounts to very nearly twice as much as by the present plan, viz. 169.4 against 90 seconds. There is therefore at the best, even with a double system of this kind against the single present system, only the gain resulting from running 6 cars instead of 4, but this is an entirely unfair way to look at it. *The operating danger is greatly increased*, so much so that no such system should be tolerated on the bridge even if it were otherwise desirable. If a collision between trains occurs, as they have repeatedly under the present system, the consequences are almost certain to be very disastrous, instead of almost certain to be insignificant, for the following reasons:

1. Both the trains are in motion at their maximum velocity, so that their united speeds will be 22 to 25 miles per hour instead of 0 to 10 miles per hour.

2. Both the trains are loaded, instead of only one.

3. One of the trains will be gripping the cable, and possibly both.

4. The collision will be *an oblique head collision*, Fig. 6, the most dangerous class, instead of a rear collision on a straight track. Terrible consequences might well ensue from such conditions.

In other words, trains cannot be operated so close together as is necessary on the bridge without more or less, and ever present danger of collision. Fogs, breakages, carelessness, a runaway horse on the roadway, a drunken row on the promenade or on the cars or in the station, a hundred different causes are liable to bring about irregularities which will cause a collision. Should this happen under the present system nothing very serious can well result; should it happen under the proposed system something too serious to be calmly contemplated can hardly be avoided. Moreover, it is far more likely to happen with the new plan than the old, because it cannot be known with certainty whether there is danger or not, until both trains are under full headway. Let us see why this is so.

Let us assume, as has been quite generally done, that the new trains are to run at the same intervals as the old, 90 seconds, or 180 seconds between trains for the same platform. Deducting the present margin of 35 seconds for irregularity in the spacing of trains, they will be 145 seconds, or 2,127 ft. apart, as the head of the first train passes *D*, Fig. 5. It has then to run in (3.4 × 8 = 27.2 secs.), stop (10 secs.), unload and load again (60 secs.) a total of 97.2 seconds, and it is ready to depart. *Then is to be committed the dangerous act*, gripping the cable, when the following train, under the assumptions, will be still 145.0 − 97.2 = 47.8 seconds off, or 701 ft. A very moderate fog, such as occurs many times a year, will make the approaching train absolutely invisible at this distance, and in the densest or "black fogs" a train can hardly be seen 50 ft. away.

The train, under our suppositions, then gets under way (10 secs.) and must move 8 car-lengths (27.2 secs.) or a total of 37.2 seconds, to clear the danger-point *D*, Fig. 5. In the meantime the following train has dropped the cable and gained for the moment some 10 seconds in the usual course, and thus the two trains pass each other just too late to avoid a collision. Such time losses are by no means an infrequent occurrence. Let there be 3 to 6 seconds more lost and the collision will take place under the conditions outlined in Figure 6, and nastier conditions for a unique and terrible catastrophe could hardly be devised. Both trains would be derailed, the whole side would be taken out of two cars, either train might foul or cut the two cables side by side under the cars, and should either cable be cut, every train on any part of the structure would be in danger of a wreck.

This indicates at once that by the new plan, trains could not be run as close together as now. They must run at 3 minute intervals to *barely* clear each other with the same allowance for irregularity of movement as now (35 sec.). To leave a margin of time properly corresponding to the great additional risk, they must be run at certainly 3 m. 30 sec. intervals. The trains would then, when running at perfectly regular intervals, clear each other at the danger-point by 65 seconds, and when out of place by the 35 seconds now allowed, they would clear each other by 30 seconds, or but little more than one train-length (22.4 sec.).

This may seem to be safe, and is safe, *if all goes well*, although the margin is not great, but it must be further remembered that the very days when there is most danger of irregularity, as notably foggy days, are those on which the greatest crowds must be handled. A very dense fog turns almost the whole stream of Brooklyn travel from the ferry to the bridge. Keeping in view also the certain rapid growth of traffic, how strong would be the temptation, as the months go by, to knock off, second by second, the time which was certainly superfluous, until at last it becomes so small *that there was no time certainly superfluous*,—in other words, no real margin of security? Habit dulls us to all dangers, and employés will take such chances in moments of emergency even in the face of the strictest orders. The same danger exists with the present system, but the difference is like that which exists between driving as close as possible to the edge of a ditch a foot deep and driving as close as possible to the edge of a precipice a hundred feet high. The one danger we can tolerate and the other we cannot. We do not believe that a practical railroad man can be found in the United States, who has had any experience in accidents and made anything of a study of them, who will say that this proposed system is a safe and proper one for handling such a traffic even at 4-minute intervals between trains for the same platform.

It is contended in favor of this proposed plan that some of the Brooklyn and New York elevated terminals handle their trains on a somewhat similar system, but the parallel is not a fair one for several reasons, the chief of which are (1) that the trains are shorter and (2) above all, they are handled by locomotive power, so that they are checked up at the point of danger, afterwards pulling out to run into the station; in other words, they pass the danger-point "under complete control." The other differences we cannot enlarge upon, but in several ways they are important.

There is furthermore one possibility which we have not as yet discussed, because it is not now used on the bridge or suggested in Mr. EMERY'S report;—the protection of trains by automatic interlocking apparatus. Absolutely, much can be done in this way, no doubt, to diminish the dangers of Mr. EMERY'S plan, but so also can much be done in the same way to increase the efficiency of the other two plans for operating the bridge, one of which is now in use while the other has not yet been considered at all, although offering a vastly greater ultimate capacity than any other.

Mr. EMERY'S plan amounts to an oblique railroad grade crossing to be used at full speed every three or four minutes by trains only a few seconds apart from each other. Under far less exacting conditions long ex-

perience has shown that the only way in which such crossings can be made safe is by automatic interlocking home and distant signals *and* derailing switches, to throw the train off the track if both these signals are run by, as they not unfrequently are by the most careful men. Such derailing switches are out of the question for a cable road, but let us now see what can be done to enlarge the capacity of the present system.

It is admitted that 4-car trains can be easily run by the present system every 90 seconds, which is equivalent to a car every 22½ seconds, against one every 17½ seconds (two 6-car trains every 3 m. 30 sec.) by the lately adopted system, leaving a gain of only 28½ per cent. of capacity with greatly increased danger. Of the 90 seconds, however, 35 seconds are merely an allowance for safety against a tail collision between two trains, one moving at 10 miles per hour *or less* and the other standing still or moving away. In a short discussion of "The Brooklyn Bridge Problem," April 16, 1887, after pointing out that less than 90 seconds headway was not now safe, we suggested:

"By the use of some special form of hydraulic interlocking apparatus, however, which would introduce some form of protecting hydraulic buffer behind a discharging train, of sufficient strength to receive and resist without undue shock the moderate impact of a train approaching at 10 miles per hour, a 60-second headway might be permitted, and, probably something of this kind will be the next step taken to increase the capacity of the bridge; but even then, the capacity has only been increased 50 per cent., allowing that the present inconvenient crowding continues. The traffic will soon outgrow this increase and the only remaining resource will be to increase the number of cars. In this direction also the possible limit under present arrangements will soon be reached, if it has not been already. Switching room cannot be had to switch much longer trains in the ordinary fashion.

"What is to be done then? We shall not attempt to surmise, but the figures for the growth of traffic in the past, and for the corresponding growth of other city traffic, indicate in a startling way that the day when this question must be asked in earnest is not far off.

"It may be gravely questioned whether some such automatically acting buffer as has been suggested, would not be even now an expedient and wise addition to the plant of the bridge. Several more or less serious collisions have already resulted which it would have prevented, and although the danger of further ones is not great, yet there is a danger and ever must be. When a discharging train is ready to be switched away the following train is within 600 ft. of it, disconnected from the cable, and moving at a somewhat higher speed than it. The constant dependence for preventing collisions is on the caution and care of employés, which means that it will certainly fail, and collisions result, from time to time. The rising of the sun is not more certain than this. If such dependence were a necessary evil, it might be borne, for as we say, the risk to each train is very small, but it is not necessary, and such an apparatus as that spoken of would not only do away with *all* risk of collision, but readily enable 50 per cent. more trains to be run at once."

We cannot improve upon the substance of this statement, written before this newest plan had come to light, but we may point out that the desired end can be accomplished in another and somewhat simpler way. A train moving at 10 miles per hour has, by the table published on page 282 of our issue of April 30, energy enough stored in it to lift itself 3.55 ft. vertically, or, taking the weight of a 4-car train at 80 tons, it has $3.55 \times 80 = 284$ foot-tons of energy. If therefore the train be compelled to lift 1 ton 284 ft., or 10 tons 28.4 ft., or 28.4 tons 10 ft., or 284 tons 1 ft., it will be brought to a stop at once by the mechanical action of this weight, and by simple modifications of pulleys, in any distance desired. Suppose it were planned to stop the train in 142 ft., as by a very easy application of brakes, with a lift of a 10 ton weight of 28.4 ft. The weight would then have a maximum velocity of 3 ft. per second, to give which to the weight (by the table referred to) requires additional energy equal to lifting the 10 tons 0.14 ft. Consequently, if this velocity were acquired by the weight in the first foot of lift it would increase the strain on the ropes just 14 per cent., which is unobjectionable. If done in 0.1 ft. the strain on the rope would be increased 140 per cent., which is still unobjectionable. If done more quickly the strain would soon become infinite, and snap the ropes. Consequently, some little easing of the first strain by springs is necessary, but not much.

Therefore, all that is necessary to do, is to devise an apparatus by which whenever a train is standing on the unloading track at the station it shall automatically throw out two hooks, on each side of the track, at a suitable distance back, into a position to engage with the front platform of any train which may improperly approach, and that train will at once be brought to a stop within the required distance, and then sent back again with nearly equal velocity, unless stopped by brakes, as it of course would be. So long as the train stood at the unloading platform it would be thus mechanically protected. When it left, the aforesaid hooks should be arranged to automatically withdraw, leaving the passage clear for the next train. The high arches of the bridge afford a convenient place for the action of such a weight, and it would have certain advantages over any hydraulic apparatus, in that it would be less likely to be out of order when most needed, because rarely called into action; which is the reason why we have suggested it, although the same thing can be accomplished hydraulically. Any one of our leading signal engineers, we risk little in saying, will undertake to erect such apparatus at very moderate cost, and guarantee its successful working, and it would not only serve to make *the present system* of operating absolutely safe, which is impossible otherwise, but still leave it absolutely safe when the number of trains was increased 50 per cent, or to 4 cars per minute, or one every 15 seconds, against one car every 17½ seconds by Mr. EMERY'S system.

This therefore should be done, and done at once, in our judgment, but one car every 15 seconds is not going to answer the requirements of the future—and of the near future—and these requirements, we think, can only be met by the third system of operating, shown in Fig. 4 above, which we have not so far discussed. Beyond the brief statement that the obstacles in the way of this plan are far less than might be supposed and its advantages far greater, since it will readily enable a car every 5 seconds to be dispatched, or 18 in every 90 seconds instead of 3 or 4 as now, and with greater convenience to the passengers, we must postpone all attempt to discuss it until a following issue.

CORRESPONDENCE.

Engineering Matters in the Argentine Republic.

69 CALLE AYACUCHO, BUENOS AYRES.
Jan. 25, 1887.

EDITOR ENGINEERING NEWS:

In connection with an article that I saw, some time ago relative to State railways, etc., it might be of interest to some to know that in this country, where there are many roads owned and operated by the State, and where the government exercises a greater or less control over private enterprises, that they are selling the roads, and a movement is on foot to make more sales. The Andine Railway—513 kilos. was sold last week to JUAN E. CLARK for a matter of $13,000,000, and accrued interest on that money for some five years. The province of Buenos Ayres owns the system known as the "provincial" and the credited rumor is, that the governor-elect, Don MAXIMO PAZ, will so strongly advocate the sale of the system as to force the provincial government—if he meets with opposition from it—to authorize the sale of over 900 kilos. of old road with many stations, and large equipments, much of it of questionable value. The road to-day is badly, and very expensively managed and maintained; it being only a machine in the hands of the Provincial government, or perhaps better say the autocrats of that government.

There are many concessions granted, and many more asked for and under consideration; most all are guaranteed up to 6 or 7 per cent. by the national government. The national government has no control over the provincial roads—or, in other words; the roads owned by the province of Buenos Ayres—in fact, the province enjoys and exercises certain rights and privileges entirely independent of the nation, and in some matters it is not altogether in accord with it. Just where the jurisdiction of a province ends, and that of the nation begins, is a small puzzle to a foreigner. La Plata, about 45 kilos. from this capital, is the seat of the provincial government. The city is the creation of the provincial government, or two of its important factors, *i. e.*, the railways and the Provincial bank, both under the autocratical direction of Sr. Don DARDO ROCHA. The city is a model of modern construction, and public architecture.

Its general plan is carefully studied, and the city may be referred to by the citizens with just pride. Its streets are magnificent, its port, in design only at present, displays engineering skill. The growth has been unprecedented in Spanish America, in fact, no city of the United States ever arrived at the grandeur of construction and full realization of careful plans, or built such solid structures, and so many of them, in so short a time,—something like five years only. The Central Railway station at La Plata—which unfortunately was destroyed by fire last night, incurring a loss of $200,000—was of grand proportions and built in the full anticipation of increasing business. The general shops of the Provincial roads, are the largest in Spanish America without doubt. I personally know nothing of their interior (they are not as yet completed) but they are said to afford all modern shop conveniences. They are at La Plata, as are the headquarters of the road. The Central Railway station of Buenos Ayres is a temporary affair, it being the ultimate design to put the central station near or in connection with the new dock system, of which much has been said and for which a concession has been granted. They are estimated to cost $19,000,000 in round numbers. The terminal station at Buenos Ayres, of the Southern Railway—which by the way is one of the best paying roads in all the Americas,—is a magnificent structure, its only fault of a grave nature being its remoteness from the present business and social center of the city. It is anticipated that the Pacific system, which includes the line from Buenos Ayres to Mercedes, thence to Villa Mercedes, thence to San Juan and Mendoza, and thence to Chili, will build large and handsome terminal building and yards here. I have spun this out into a disjointed and scattering description of what is really worthy of much more attention. I shall hope to send you fuller descriptions of the more interesting matter later.

Yours truly, F. L. GRISWOLD.

Standard Time.

May 2, 1887.

EDITOR ENGINEERING NEWS:

The use of the word standard suggests a stopping place. The so-called standard railway time having no scientific origin and no continuous numeration in relation to space is no true standard of time; for time and space are mathematically convertible terms. Time not based upon continuous relation to space, beginning nowhere, ending nowhere, and convertible to different times at different meridian intervals, is not standard properly so called, but variable time subject to successive correction because not in harmony with its relation to space.

Until the civilized world adopts one prime meridian there can be no standard time. Time means 15° per hour for 24 hours; and for the convenience of all nations should be counted from zero at one principal meridian.

A timepiece cannot be made to show standard, much less universal, time, unless one hand registers zero when the sun is upon the principal meridian

regardless of where the timepiece may be at that particular instant. Let one hour and one minute hand therefore, so register, and another hour and minute hand point the hours east or west of the meridian of Greenwich, wherever the watch may be found, and let the local hands be adjustable, independently of the prime meridian hands.

If this timepiece be taken, say from New York to Greenwich Observatory, it is plain that it will read correct time there, and also at the place it came from.

If desirable to make this watch show intermediate time (and the place were remote from civilization) it could be done with a sun or other observation, and, having booked the time of the principal meridian hands when the observation was taken, the longitude would be known in the same manner as the chronometer is used at sea, and the local hands could be set to the local time.

Such a timepiece rated by a succession of meridian passages of stars to find its gain or loss on mean time, could, in conjunction with a sextant be used to find approximately the true position ashore both in latitude and longitude. If the sailings from Liverpool, trains from New York, and boats from San Francisco, etc., were based upon principal meridian time, a traveler might make a circuit of the civilized world, and calculate his connections without making any allowance for the passage of time belts. He could correct his local time by comparison without any complication arising, or interference with the principal meridian time; his watch showing the latter in all places, and the former whenever he chose, to alter his local time for a change of meridian. There are different kinds of time in use, as for instance, civil, nautical and astronomical time.

When the traveler in a wild country has occasion to use the Nautical Almanac or epitome of navigation for the first time, he will be three times more puzzled than he would be, if the Nautical Almanac, American Ephemeris, Canadian Almanac,etc., were all assimilated, and reduced to one time origin, and one class of time for all.

An improvement of this kind would be a revolution of simplicity in a chaos of confusion, a gain to mariners, guide to travelers and a decided advance in civilized usages.

The so-called standard time cannot be used at sea, and a time standard, neither continuous nor available at sea should never be adopted on shore. Constituted as at present, it is an arbitrary improvement made useful by the adoption of geographical intervals, and successive corrections of accumulating differences, based upon no fixed principles, inherently defective and impossible of universal application.

The adoption of time belts may be convenient for east and west transportation, but a decided stumbling block for any road running north and south, so located as to cross and recross the edge of a time belt.

What is the analogy between the old numeration of time and the new, but as unscientific attempt to grapple with an everlasting truth, by means of a mechanical expedient, a cotton patch upon the seat of Old Time's buckskin breeches, a "*vox et preterea nihil.*"

But there is a grand opportunity for science to suggest a remedy for one of the greatest needs of the present age; one standard of universal time with one initial meridian, side by side with the local time standards, the former continuous in numeration and used for transportation purposes throughout the commercial and civilized world, the latter being conserved for stationary, household and local use.

TIEMPO VIEJO.

Price for R. R. Fencing and other R. R. Materials.

SUNBURY, Pa., May 23, 1887.

EDITOR ENGINEERING NEWS:

Can you give me an idea as to the price paid by railroad companies in the west for fencing in large jobs? Are terra-cotta posts in use and to what extent? What are the prevailing prices for material and kinds of material generally used?

D. C. KASEMAN.

[We could make some fairly approximate guesses in answer to the above queries, but we prefer to hear from such of our readers as are better posted than we can possibly be. We will be obliged for early replies.—ED. ENG. NEWS.]

A Question of Dynamics.

EDITOR ENGINEERING NEWS:

I have just had the pleasure of reading your editorial of 14 inst., replying to my criticism of your explanation of the positions of two colliding locomotives; and notwithstanding your efforts for my enlightenment, I cannot but "be of the same opinion still."

When two trains approach each other, each with a velocity (relatively to the track) of 30 miles per hour, their velocity *toward each other* is 60 miles per hour, and it is *this* velocity which must be squared in getting at their energy relatively to each other, although in order to ascertain the energy of either *relatively to a stone resting on the track* we should use the *single* velocity of 30 miles per hour. Your division of the velocity of approach of 60 miles into two velocities of 30, in calculating the energy of approach, is, I think, as inadmissible as the attempt of the man with a wife aged forty to exchange her for two twenties.

A bullet will penetrate a clay bank to the same depth whether it move toward the bank, or the bank toward it, with a given velocity, but if each move toward the other with half of that velocity, then, by your reasoning, the penetration should be only half as great, and it would be different for each manner of distribution of the velocity between the bullet and the bank.

That this is a *reductio ad absurdum* is evident when we consider that we know of no such thing as absolute velocity or absolute rest, and that for all we know, the bullet and bank, which we regard only as moving toward each other, may be (and almost certainly are) absolutely chasing each other through space.

But even if we could admit that the *force or energy of the collision* is affected by the relative standing or moving of the trains relatively to the track, this would seem to "have nothing to do with the case," as regards the question as to which of the two shall be on top after the collision. With whatever force two moving bodies come together, if their meeting faces are rigid and perpendicular to their line of motion, and if that line cuts those faces, neither body can deviate from its path. But if either forms an inclined plane up which the other can ride, said other will ride. I therefore, agree with Mr. ALLEN that the question as to which engine shall be uppermost is dependent, not upon which engine is moving and which standing, but upon some peculiarity of shape, hardness, strength, position, etc., of the abutting surfaces.

I still entertain the hope that you may be led to see it in this light; but, in any case I beg to remain Your, VALUED CORRESPONDENT.

LOWELL, MASS., May 17, 1887.

EDITOR ENGINEERING NEWS:

In ENGINEERING NEWS of May 14, in an article entitled "A Question of Dynamics," you appear to me to have made an inaccurate statement, when you affirm that if two trains collide with velocities of 30 miles per hour, the crushing and breaking will only be one-half as great as it would be if one of the trains were still and the other struck it with a velocity of 60 miles per hour.

If two inelastic masses, M_1 and M_2, move in opposite directions, and called with the velocities v_1 and v_2, it is easily proved that the energy lost by the collision is proportional to the expression

$$\frac{M_1 M_2}{M_1 + M_2}(v_1 + v_2)^2$$

[See Weisbach's Mechanics, page 675.]

This expression shows that if two trains, of equal weights, move in opposite directions, and collide with equal velocities, the energy due to the motion will be totally destroyed at the instant of the collision; but if one of the trains is at rest, and the other strikes it with twice the velocity that it had in the former case, only half of the energy of motion will be destroyed at the moment of the collision; and since it is the energy thus destroyed that causes the crushing and breaking, the account of such work done in the first case will be the same as in the second. It does not follow from this, however, that the resulting positions of the trains would be the same in both cases. On the contrary it seems to me that they would be quite different. Yours truly, F. GILMAN.

[Crushing and breaking are doing WORK. Work is measurable in foot pounds, and is storable in the train in the form of velocity. The total work done when two trains come to rest, and before they can come to rest, must be just sufficient to destroy the energy stored in them, either by lifting them against gravity or by crushing their parts, or otherwise. The total work in foot-pounds stored in a body of weight M, and velocity v, is as $M v^2$. The total work stored in two bodies M, each having a velocity of $\frac{1}{2} v$, is $2 M (\frac{1}{2}v)^2$ or $\frac{1}{2} M v^2$. Consequently, if two trains weighing $2 M$ have *each* a velocity of 30 miles per hour, they have only *half as much* energy in foot-pounds stored in their aggregate mass, as if one train were standing still and the other moving at 60 miles per hour. Consequently, their united energy will be only equal to lifting their united mass half as high before they come to rest (the exact figures, by the table which we published on page 282 of our issue of April 30, being 31.95 ft. against half of 127.80 ft.). Consequently, only half as much crushing or breaking must be or could be done before they come to rest, Q. E. D.—ED. ENG. NEWS.].

JERSEY CITY, May 7, 1887.

EDITOR ENGINEERING NEWS:

What kind of a design would you suggest for an elevated road in Broadway? Is there not something better than the ones now in use in this city?

Yours truly, A. B. VOSTINE.

[The only proper elevated road to erect in Broadway or any other street of New York, unless along the docks, is a four-track stone-ballasted structure running through the blocks, and spanning the cross streets from house-line to house-line by single span plate girders. This, at least, is our opinion. Such a structure promises the maximum of public convenience, and probably of private profit as well, with the minimum of disfigurement and injury to property. By carrying the grade line 20 to 50 ft. above the streets the ground under the structure would be easily rented, while there need be no fixed limit whatever to the speed and length of trains. But the ignoble desire to grab the streets for nothing from the city seems to have such a fascination that the chance for much greater ultimate profits in a legitimate way is not perceived.—ED. ENG. NEWS]

PUBLICATIONS RECEIVED.

Institution of Civil Engineers. "Notes on Useful Japanese Timber," by JNO. HENRY T. TURNER, "Iron and Brass Foundries, Pouist St. Charles Works, Grand Trunk R.R.of Canada,"by FRED LUMB WANKLYN, 'Australian Timber," by GEO. CHAMIER. "Setting out the Curves of Wheel-teeth," by WILLIAM ISAAC LAST. "Salmon Fi-heries in Scotland," by ALEXANDER LESLIE. "Ailsa Craig Lighthouse and Fog Signals," by DAVID ALAN STEVENSON. "Administration of Fishing-boat Harbors in France." "Further Investigations regarding Wire-gun Construction," by JAS. A. LONGRIDGE.

Messrs. A. H. HOWLAND and GEO. A. ELLIS, civil and hydraulic Engineers of Boston, Mass., have issued a very original professional card in the shape of a handsomely printed book of 160 pages, entitled "Water." Aside from its personal character, the book contains a great deal of matter interesting to builders of waterworks in the shape of useful tables and sound practical hints on mains, distribution, stand-pipes, pipe-laying, etc.

The Chronicle Fire Tables for 1887; a Record of the Fire Losses in the United States by Risks, States and Causes during 1886, with Exhibits of the Monthly Annual and Aggregate Fire Losses in the United States during Twelve Years (1875-1886) Etc.. New York. The Chronicle Co. Limited. 195 pp. chiefly tables; numerous diagrams and plates.

It is always pleasant to receive publications which of

their kind and in their field may be called thoroughly satisfactory, as these tables certainly may. They can hardly fail to be studied with interest and profit. The tables show that in the past twelve years $1,011,448,994 worth of property has gone up in smoke in this country, the present rate being about $110,000,000 per annum. This rate shows a startling tendency to rise and fall with the condition of business and the number of failures, the average per cent. of *known* incendiary fires being 26 per cent. which rises in many States of the South (where incendiary fires are most frequent) to over 50 per cent. A strange and unaccountable tendency to many more incendiary fires in certain months than others is also shown, similar to that which is well known to exist with suicide and other crimes.

These and many other facts are brought out by diagrams, while the tables are remarkably complete. As we hope shortly to use them as a basis for a discussion of the pros and cons of the timber supply question, we will not now attempt a more complete summary.

PERSONAL.

J. W. DEEN is the Engineer in Charge o e Glenwood Springs & Aspen extension of the Denver & Rio Grande R. R.

JOHN H. GRAY has been appointed General Superintendent of the Texas Western Ry., with headquarters at Houston, Tex.

C. W. BRYAN, late Principal Assistant Engineer of the Edge MOOR Iron Co., Wilmington, Del., has resigned to accept a position in the bridge department of the Missouri Pacific Ry., with headquarters at Washington, Mo.

A. H. SALISBURY has been elected Superintendent of the Lawrence (Mass.), Water-Works, in place of HENRY W. ROGERS, resigned. Mr. SALISBURY has been Assistant Superintendent since the construction of the works, and in his promotion the Water Board have done themselves credit.

CHANGES OF ADDRESS, MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

CALVIN E. BRODHEAD, Lock Box 595, Scranton, Pa.

FRANK L. FULLER, Civil and Hydraulic Engineer, 12 Pearl St., Rooms 35 and 36, Boston, Mass.

ARTHUR HAVILAND, (Haviland & Brittain,) Kampmann Building, San Antonio, Texas.

HARRY L. VAN ZILE, Troy and Albany Bridge & Iron Works, 55 N. Pearl St., Albany, N. Y.

PRESTON K. YATES, Chief Engineer Natchez Water Co., Natchez, Miss.

F. M. WILDER, 160 Broadway, New York.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—Meeting of June 1. President WORTHEN in the chair. The Secretary stated that no change had been made in the Convention programme as previously announced. An arrangement had been made whereby Western members paying full fare to the place of meeting would be entitled to a return ticket at one-third rate. The Secretary than gave a very full abstract of a paper on the "German system of Permanent Way with Iron Substructure," prepared by himself and illustrated by plans.

The following gentlemen were announced as elected to the Society:

FOR MEMBERS:—FRANK BRUEN (Cornell Univ. 1878.) formerly engaged on Dayton and Southeastern Ry.; Dayton, Covington and Toledo R. R.; Missouri River Construction Work; Assistant Engineer Union Pacific Ry.; Assistant Engineer Maintenance of Way, afterwards Resident and then Division Engineer Utah and Northern Branch U. P. Ry.; recently Assistant Engineer Bitter Root and Rocky Mountains, Montana Ry.; now Civil Engineer, New Haven, Conn.

HENRY MANSON BYLLESBY, formerly engaged in Laboratory of Edward Weston; with Robert Wetherill & Co., Chester, Pa.; erecting Corliss Engines and Mill Machinery; in charge of erection large Central Station Plants, Edison Electric Light Co.; Manager Edison Light Companies of Canada: now Vice-President and General Manager Westinghouse Electric Co., Pittsburg, Pa.

SAMUEL BARRETT CUSHING, formerly engaged in charge of Construction South Manchester Branch Hartford and Providence R. R.; East Providence Branch of Providence and Worcester R. R.; recently and now engaged in designing and building wharves, dams and bridges, Providence, R. I.

HERBERT CLARK FELTON, (Rens. Pol., 1866,) formerly engaged with Novelty Iron Works, New York City; Assistant Engineer Manchester and Camden and Medford and Camdem Railroads in New Jersey; Engineer in charge preliminary surveys Wichawken Ry.; Chief Engineer New York and Fort Lee R. R.; Engineer Dutchess and Columbia R. R.; Chief Engineer Medford and Camden R. R.; now Secretary, Treasurer and Superintendent Kaighns Point and Philadelphia Ferry Co., Camden, N. J.

SILAS BENT RUSSELL, (Wash. Univ. St. Louis, 1881.) (Elected Junior June 3, 1884,) formerly Assistant Engineer and now Engineer in charge of Water Distribution of St. Louis, Mo.

ROBERT SOMERVILLE, (Univ. Va., 1869) formerly Assistant Engineer Chesapeake and Ohio R. R.; Assistant and afterwards Resident Engineer on Construction Big Sandy R. R. in Kentucky; Assistant Engineer Eastern Extension Chesapeake and Ohio R. R.; recently U. S. Assistant Engineer in charge of Levee Work in Bolivar Co., Miss; now Assistant Engineer Board of Mississippi Levee Commissioners, Greenville, Miss.

WILLIAM PARSONS WATSON, (Yale Coll.) formerly Superintendent Du Pont & Co. Powder Works at Sycamore, Tenn.; in charge for Contractors B Street Outlet Sewer, Washington, D. C.; in charge of Surveys on Rivers and Harbors in Maryland and Virginia under S. THAYER ALBERT, U. S. Civil Engineer, M. Am. Soc. C. E.; Resident Engineer in charge of Construction Northern Pacific R. R.; recently Resident Engineer in charge Location and Construction on Mountain Division Canada Pacific Ry.; now resident Engineer in charge of Location and Construction Montana Central Ry., Helena, Montana.

FOR JUNIORS:—BENJAMIN DOUGLAS, formerly Assistant Engineer Detroit, Bridge and Iron Works; now Engineer of Bridges Michigan Central R. R., Detroit, Michigan.

JOSEPH YENDES WHETLEY, (School of Mines, Columbia, Col. 1886,) formerly Assistant Engineer New York, West Shore and Buffalo Ry.; Assistant Instructor in Surveying at School of Mines, Columbia College: now Assistant in Chief Engineer's Office New York Central and Hudson River R. R., New York City.

Civil Engineers' and Surveyors' Association.—The annual meeting of the Connecticut Civil Engineers' and Surveyors' Association will be held at the office of CHAS. E. CHANDLER, 161 Main St., Norwich, Conn. on Tuesday, June 7th. There will be excursions to points of engineering interest during the day, and at 7 P. M. a paper on "The Relation of Photography to Engineering" by W. H. BURNETT, of Norwich, will be read.

The American Institute of Mining Engineers will hold its 48th meeting in Utah and Montana, beginning at Salt Lake City on July 6th. The excursion train leaves Chicago by the C. B. & Q. R. R. at 12.30 P. M. July 1.

This excursion will be personally conducted by an experienced manager from the traveling agency of THOS. COOK & SON. The price to each member of the party, including railway fare, Pullman sleepers, meals, first-class hotel accommodations, etc., from the time of leaving Chicago to the time of arriving at Duluth, July 24, will be two hundred and sixty dollars ($260).

Application for places must be made to THOS. COOK & SON, 261 Broadway, New York City, accompanied with a New York draft or postal order, payable to them, for $25 for each person. They will at once return a "deposit receipt" securing the place of the applicant. The remainder of the total price, viz., $235, must be similarly remitted to them, at their New York Office, on or before June 25th, when they will forward tickets, etc.

Those wishing to join the excursion at Denver or Salt Lake should make application and remittance of $25 as above, and will be informed by Messrs. COOK & SON of the reduced price at which they can secure places.

This excursion is open to ladies accompanying members or associates; to the families of members or associates; and to persons proposed for election as members or associates, and ladies accompanying them.

The detailed programmes of sessions, etc., at Salt Lake and Butte will be arranged by the Local Committees at those places. Letters of inquiry on these subjects may be addressed to Mr. JOSEPH R. WALKER, Salt Lake City, or Mr. C. W. GOODALE, Butte, Montana.

The Forty-ninth meeting of the Institute will be held at Duluth, Minnesota, beginning Tuesday evening, July 26th. The detailed programme of this meeting will be either communicated in a later circular from this office, or handed to members on their arrival at Duluth. At present it can only be said that there will be—besides the hospitalities and pleasures of Duluth and its harbor—excursions to the Vermilion and Gogebic Mines. Letters concerning this meeting may be addressed to Mr. R. S. MUNGER, Duluth, Minn.

New England Water Works Association.—The Sixth Annual Convention will be held at Manchester, N. H., June 15, 16 and 17. Headquarters at Hotel Windsor. Early application for hotel accommodation must be made to Mr. CHAS. K. WALKER, Supt. Water-Works, Manchester. The convention will be received by the Mayor of Manchester, in the Court House, at 3 P. M., June 15, and after address and reports of committees, EDWIN DARLING, Supt. Water-Works, Pawtucket, R. I., will read a paper on "Some Practical Details of Water-Works Management." Among other papers to be read during the convention are: "The Water Tank at Fall River, Mass.," by PATRICK KIERAN, Supt.; "Some Legal Aspects of Questions relating to Water Supply," by E. W. CATE, Commr., Newton, Mass.; "Ware Water-Works," by FRANK L. FULLER, C. E., Boston, Mass.; "Some Remarks on Methods of Collecting Water Rates," by JAS. H. HATHAWAY, Water Registrar, New Bedford, Mass.; "Aeration and Filtration," by CHAS. B. BRUSH, C. E., Hoboken, N. J.; "Ashland Basin No. 4 and the Mixing and Handling of Concrete," by W. F. LEARNED, C. E., Watertown, Mass. Many practical questions will be discussed. On the 17th the convention will be the guest of the city and there will be an excursion and collation. For further particulars as to trains, prices, etc., address ALBERT S. GLOVER, Secty., West Newton, Mass.

Liverpool Engineering Society. A meeting of this Society was held at the Royal Institution, Colquitt St., Liverpool on Wednesday May 11th, Mr. JOHN I. WEBSTER M Inst. C. E., President, in the chair. A paper was read by Mr. J. F. WADDINGTON on "Submarine Vessels". In commencing the paper the author gave a brief history of what had been done in Submarine Navigation. There were records of submarine vessels far back as 1648, and a very interesting series of experiments was made by Fulton in 1801. Submarine vessels he stated were used in the American Civil War and numbers of patents had been taken out in America, none of which however had come to anything. He then referred to the submarine vessel the "Resurgam" designed by Mr. GARRATT and tried in the Birkenhead Float in 1879, and also the Nordenfelt boats which were also from Mr. GARRETT'S designs. His own submarine vessel the "Porpoise" which was tried last year before the representatives of the British and Foreign Admiralties was then described. She was, he said, 37 ft. long, by 6 ft. 6 in. beam and was arranged to be propelled by electricity. The "Porpoise" was submerged when under way by means of inclined planes, which when the bouyancy of the vessel had been sufficiently reduced by taking in water, were set over at an angle and so guide the vessel below the sea surface. He also described the horizontal propellers working in vertical tubes used in his boat for the purpose of diving below in cases of emergency when there was no way on the boat. The great danger with submarine vessels of suddenly diving by the head, when going at any speed, was then dealt with, and he showed how by means of a horizontal rudder arrangement actuated by an automatic electric steering gear he had met this danger. Compressed air for consumption by the crew was, he said, carried in two compartments at the ends. For the propulsion of the vessel and for driving the various machinery on board the vessel, the electricity was stored in 45 accumulators of 600 ampere hours capacity. The maximum current taken by the motor was 66 amperes, the E. M. F being 90 volts, thus giving an electrical horse power of 7.96 with a motor of 8 per cent efficiency, the actual horse power would be 6.77. The author stated the speed of the boat with this power would be about 8 miles per hour, at which speed she would be able to run a distance of 80 miles.

Mr. T. C. MARTIN, the new President of the American Institute of Electrical Engineers says in his inaugural address:

"The electrical statistics of to-day are nothing short of colossal. To go no further than our own country, we find an investment and capitalization in simply the leading electrical industries—telegraphy, telephony electric lighting and electric power—of a sum of, at least, $350,000,000. There are in America about 700,000 miles of telegragh wire. Last year 320,000,000 telephonic conversations were held. Over 150,000 arc lamps, and incandescents verging on 1,000,000 now instruct the public eye that the electric is the light before which all others must pale their ineffectual fires. At least 10,000 electric motors are employed in the most varied industries, and while the electric railways here are carrying passengers at the rate of more than three and one half millions annually, the extraordinary increase now going on in that branch promises that the figures will be doubled within the year, with at least from 50 to 75 electric roads in operation When to these figures we add the thousands of dynamos and vats used in electroplating, the countless electric appliances used in medicine, surgery, and the miscellaneous arts, and the endless variety of electric apparatus for convenience, safety, protection and comfort in the house, office, train or hotel, we arrive at sum totals dealing with which a statistician needs all his ability to mass and classify.

TECHNICAL NOTES.

"SILOTWOR" is the last new explosive, "ten times as strong as gunpowder." It is a Russian who found it this time.

THE Michigan Legislature has passed a bill which compels railroads to build right of way fences within two months after commencing the running of trains.

The Engineer, of May 9, corrects the statement recently made that the 30.06 miles per hour made by a Thornycroft torpedo-boat for the Spanish navy was the fastest time yet made by such a vessel. It says that Messrs. YARROW & Co. have built a torpedo-boat which attained a maximum speed of 31.44 miles, or 27.277 knots per hour.

BOAT oars are being made by JOHN YATES & Co., of Birmingham, England, with the blades of best sheet steel, highly tempered. The handles are of spruce or ash with a socket running nearly the whole length of the blade. These oars are very strong, and being thinner enter and leave the water cleaner than wooden oars; but they are heavier.

THE German Imperial Railway Bureau, in its report for 1885-6 says that the present total length of German railways is 23,160 English miles, with 455 miles built in the preceding year. Of this mileage 20,237 miles are government roads, while of the remainder 288 miles are private roads under government administration; 1232 miles are private annex lines and 238.6 miles are narrow-gauge.

WE are told in a solemn way by the Hartford *Courant* that "the directors of the New Haven & Derby road held a quarterly meeting on Monday the 16th ult. and voted to equip all the passenger cars with the Westinghouse automatic brakes." Whether it is noted as a sign of progress that a Connecticut passenger road should be taking such action in A. D. 1887 we cannot say, but from the tone of the note we infer it is. The directors have certainly acted wisely, if not over-promptly.

ON the Chicago & Northwestern Ry. brakemen run 2,300 miles for a month's work and are paid extra for every mile over that distance that they travel. On many other Western roads 2,600 miles is fixed upon as a month's run. The Southern Pacific brakemen struck last week, claiming that for months past they had averaged 4,400 miles a month without extra pay, and demanded that 2,800 miles should be the limit. A compromise was arranged whereby 3000 miles was agreed upon, 2 cts. per mile to be paid for all mileage made over that figure.

THE U. S. Government has been observing daily since 1859 the height of water in Lake Michigan at the Milwaukee lighthouse. It is found that the lake annually rises and falls from 12 to 18 in. The highest known water, since 1859, was in Sept. 1886; the lowest stage in the same 27 years was in Feb. 1873. The annual flood tide of the lake is in September and October, and the annual ebb is in January. The greatest difference in level noted in any one year was in 1871 when it was 2.6 ft. higher in the fall than in the preceding winter.

THE progress of railways in the Argentine Republic has been quite as notable, proportionately, as in this country. So recently as 1885 there were only 11 railways in the country aggregating 2,290 miles and built at the very reasonable cost of about $34,000 per mile. Since 1885, up to the beginning of the current year 1,082 miles more, costing about $25,000 per mile had been built, while lines are now in progress which will give an aggregate system of 5,000 miles, with a tendency to develop still more projects. As the whole population is only some 3,000,000 (which is growing rapidly) this is a very creditable record, aggregating about a mile of road for every 1,000 inhabitants which is far above (about double) the ratio of any country in Europe, and only exceeded by this country and the Australian Colonies. In many ways the Argentine Republic is showing a notable spirit of progress.

A New Vertical Boiler.

A new boiler has recently been patented, and will shortly be placed on the market by the Vertical Tube Boiler Co., of this city. The boiler consists of two cylinders of unequal diameter, set vertically, one within the other, connected at top and bottom and by stay bolts. The annular space between them contains the water, and the furnace is placed in the center. An iron jacket, lined with mineral wool, and somewhat larger than the outside cylinder, covers the whole, and the gases of combustion passing upward from the fire, go over the upper end of the boiler and thence down between the outer shell and the jacket, being taken away at the bottom. Short horizontal tubes, closed at one end and opening into the water space at the other, project radially from the surface of the inner and outer shells, and supply a large amount of heating surface in a small space.

The following is a report sent us by Mr. JOHN WILSON, of an evaporated test of this boiler, made May 5.

Duration of test	10 hrs.
Coal consumed, (large size chestnut)	1,950 lbs.
Residuum	330 lbs.
Water evaporated	22,001 lbs.
Evaporation per pound of coal	11.28 lbs.
" " " combustible	13.58 lbs.
Average steam pressure	94 lbs.
" temperature of boiler room	73.5° Fah.
" " " feed water	141.8° Fah.
" " " waste gases	465° Fah.

The above figures indicate an evaporation per pound of combustible, from and at 212°, of about 15 lbs. But as we do not understand that any calorimeter determinations were made at the test, this rather surprising result is explainable.

STATISTICS OF NEW WATER-WORKS CONSTRUCTION.

(*Specially Communicated.*)

CONTINUED FROM PAGE 353.

Fort Gratiot, Mich.—The works were commenced in the fall of 1885 and were accepted June 1, 1886. Superintendent AVERY, of the Port Huron Water-Works, was Consulting Engineer. The contractors were: for masonry, foundations and buildings, J. C. Kanmier, of Fort Gratiot, $2,800; pumping machinery, M. Walker, of Fort Huron, $5,000 complete; pipe, specials, trenching and pipe laying, National Tube Works, McKeesport, Pa.; valves, Galvin Brass & Iron Works, Detroit; hydrants, Ludlow Valve Manufacturing Co., Troy, N. Y. The price for trenching and pipe laying was 10 cts. for 2-in. pipe and 12 cts. for larger sizes up to 8-in.; this price including setting all specials and hydrants, hauling, etc., complete. During 1886 about half a mile of kalamein pipe was laid. The franchise is owned by the village. J. A. MCMARTIN is Superintendent. The present population is estimated at 2,200.

Norwood, Mass.—The works were commenced in June 1885, and accepted in November 1886; they were designed and constructed by PERCY M. BLAKE, of Hyde Park, Mass. The contractors were: for masonry, foundations and buildings, F. A. Fales, Norwood,; pumping machinery, Davidson Steam Pump Co., New York; pipe and specials, Warren Foundry Co., Phillipsburg, N. J.; trenching and pipe laying, J. T. Langford, Newton, Mass.; valves and hydrants, Chapman Valve Co., Boston; reservoir, James C. Mitchell & Harris, Boston. The reservoir has an average height above the town of 125 ft., and a capacity of 1,500,000 galls. The franchise is owned by the town. J. E. EVERETT is Superintendent. The present population is estimated at 3,000.

Cobleskill, N. Y.—The works were commenced Sept. 1, 1886, and are not yet completed, about one third of the work having yet to be done; the works were designed by WM. N. ROBERTS, of Cobleskill, who is Constructing Engineer. The contractors for the masonry, foundations, buildings, trenching, pipe laying and reservoir are Stanton & Doyle, Cohoes, N. Y.; for pipe and specials, Warren Foundry & Machine Co., Phillipsburg, N. J.; for valves and hydrants, R. D. Wood & Company, Philadelphia; the Eddy valve is used. The price paid for trenching and pipe laying ranged from 18 to 55 cts. per lin. ft. The franchise is owned by the village and the works are controlled by the Cobleskill Water-Works Co.; President, M.O. BORST; Secretary, GEO. D. HARDER. The present population is estimated at 2,000.

(TO BE CONTINUED.)

NOTE.—The above statistics of new construction are sent in response to special inquiries sent out by us to contractors, superintendents, engineers and others having to do with new works. We have a special blank for this service, and will be pleased to forward one or more on application. We invite co-operation in this special subject.

CONSTRUCTION NEWS.

Water.

WE will be obliged if every water-works superintendent or engineer, or other official in charge of the distribution of their official printed reports, will see that this office is furnished with a copy of each report issued since 1884, and also give us rates at which water is sold by them. We will be careful to acknowledge receipt of such reports and wherever there are any novel features of importance to the general public, we will be sure to note them in the columns of this journal. Early information also about elections of officers; about extensions of works; the purchase of new machinery and other news of direct interest to parties engaged in the construction and management of water-works is specially solicited. Be careful to address all correspondence to Tribune Building, New York City.

The National Water Purifying Co., though but recently organized, reports numerous sales made in different parts of the country to towns and mills. The filter and system is so simple that it meets with favor everywhere.

Artesian Wells.—Woodhull, N. Y. A well is to be driven.—Ocean Grove, N. J. Water has been struck at a depth of 416 ft.—Sherman, Tex. The Texas & Pacific R. R. Co. will put down a well.—Navasota, Tex. Water has been struck.—Gainesville, Tex. The water company has put down a well to secure a supply as a supplement to its river supply.—Dublin, Tex. A company, with a capital stock of $3,000, has been organized to furnish a supply of artesian water.

Watervliet Water Power Co.—The original rights of this company, of Watervliet, Mich., near Paw Paw lake in Berrien Co., have been purchased, and surveys have been made for the improvement of the Paw Paw river which demonstrate that a waterway can be secured from Benton Harbor to the lake, a supply of pure water and a fall of 40 ft. obtained and 3,000 H. P. can be developed for manufacturing purposes, within three hours of Chicago, by rail or lake steamer. The lake has an area of about 1,800 acres. The proposed works will cost $300,000, of which Benton Harbor will pay $40,000, authority for this payment having been voted by the Legislature. J. P. THRESHER, of Benton Harbor, Mich., is Secretary of the company.

IN the compilation of Statistical Tables of American Water Works, special efforts were made to have them as accurate as possible. Errors have occurred in a few instances which have been brought to our attention, and we especially solicit early information of *any errors* that *any person* may discover, so that they may be corrected. The range of information in future editions will be greatly extended, and we now invite suggestions upon the features most desirable, from water-works officials, engineers, contractors, and parties dealing in machinery and other supplies for water-works. ALL CORRESPONDENCE, ALSO ALL REPORTS, MUST BE ADDRESSED TO ENGINEERING NEWS, TRIBUNE BUILDING, NEW YORK, as future issues will be compiled in this office and under our personal supervision.

Columbus, O.—The Trustees of the Water-Works have submitted their report for the year ending March 31, 1887, being the seventeenth annual report. The works are reported to be in good condition and the supply ample, but an increased supply is recommended for the near future. During the year 10,572 lt. of 8, 6 and 4 in. pipe have been laid, and 27 hydrants set. The works were built in 1871 and are owned by the city; the source of supply is ground water and the direct pumping system is adopted. There are two Holly, quadruplex, condensing engines with a daily capacity of 4,000,000 galls. each, and one Gaskill horizontal, compound, condensing engine, with a daily capacity of 10,000,000 galls The total consumption was 1,933,809,134 galls. The distributing system consists of 69.22 miles of 4-in. to 24-in. pipe, 555 fire hydrants, 539 line valves, 486 elevator and hydrant valves and 4,531 service connections. Tables of engine performance, expenses, etc., accompany the report, together with the full text of the by-laws and regulations. The present population is estimated at 80,000. 25,000 using the water. President, ISAAC B. POTTS; Superintendent and Chief Engineer, A. H. MCALPINE.

Water Companies.—The Diamond Island Water Co. has been incorporated at Portland, Me., to supply Diamond island, in the harbor. President, FRANKLIN M. LAWRENCE; Treasurer, SETH L. LARRABEE. Capital stock, $5,00 .——The Southwest Harbor Water Co. has been incorporated at Southwest Harbor, Mount Desert, Me. President, H. H. CLARK; Secretary, A. ALLEN.——The North Chattanooga Water Works Co. has been incorporated at Chattanooga, Tenn., to build works for the new town to be established by the Chattanooga Land, Coal, Iron & Railway Co. President, S. W. ADAMS; Secretary, W. T. BURKAM.——The Ridgedale Water Co. has been incorporated at Chattanooga, Tenn., with a capital stock of $10,000.——The Jeffersonville Water Works Co. has been incorporated at Jeffersonville Ky., by HORACE SCOTT, FLOYD PARKS and others. Capital stock, $125,000.——The Great Falls Water Power & Town Site Co. has been incorporated at Great Falls, Choteau county, Mont., by CHARLES A. BROADWATER, V. GIBSON and LOUIS G. PHELPS. Capital stock, $5,000,000.——The Tyler W ter Co. has been incorporated at Tyler, Tex., by H. H. ROWLAND, J. J. DAGTISH, of Tyler, and others.——A water company has been organized at Beaumont, Tex., by Dr. Z. T. TULLER, J. J. CRICHTON and others. Capital stock, $30,000.——The Wa erville Water Co., Waterville, Me.' has elected the following officers: President, G. A. PHILLIPS; Treasurer, WESTON LEWIS; Clerk, E. F. WEBB; the Directors are ARTHUR SEWALL, FRANK JONES, PAYSON TUCKER, J. S. MAXY and T. W. HYDE. The capital stock of the company is $200,000 Material is being delivered.——The Omaha Water-Works Co., of Omaha, Neb., has increased its capital stock from $800,000 to $1,600,000.——The Waco Water Co., of Waco, Tex., has filed a mortgage to secure a new issue of bonds for $150,000. W. W. SELEY is Trustee.——The San Gabriel Land & Water Co. has been incorporated at Los Angeles, Cal., with a capital stock of $600,000.

New Water-Works.—Waterville, Me. The water company proposes to take its supply from the Emerson stream, but the people want it from the Kennebec.——East Hartford, Conn. A water company has been incorporated and the source of supply has been decided upon.——Great Barrington, Mass. The litigation between the old water company and the new Berkshire Heights Water Co. has been decided in favor of the latter. The new company will introduce water from Green river.——Westfield, Mass. A new reservoir is recommended.——Towsontown, Md. Land has been acquired by the Towsontown Water Co. for its reservoir and the contract for boring the well and supplying the pipes, etc., has been awarded to the Miller Artesian Well Co., of Baltimore.——Deer Park, Md. The B. & O. R. R. Co. has laid pipes to convey water from the boiling spring.——Ashtabula, O. Work is in progress at the pumping station and mains will be laid at once in the First Ward.——Macon, Ga. A new Worthington pump with a daily capacity of 1,000,000 galls. is being put in. A. E. BOARDMAN is Superintendent.——Dallas, Tex. Mr. BROWN, of New York, has made a proposition to furnish a daily supply of 2,000,000 galls. at an annual cost of $19,000, or $12,000 less than it costs to run the present service and pay interest on the bonds. An artesian well is to be sunk as an experiment.——The Weirs, N. H.——Ashburnham, Mass.——Fairbury, Ill.——Greenville, Mich.——Seward, Neb.——Montrose, Col.——Crescent City, Fla.

WE have mailed a free copy of Statistical Tables of American Water Works of 1887 to every waterworks company, public or private, listed in the Tables: to make sure of their having been received, we notify all those sent to by postal card of our action in the matter, and in a number of cases we have duplicated the sending on account of the first book having been lost in the mails. *If there is a single water-works office in the United States or Canada* where at least one copy of our Statistical Tables cannot be found, we will be obliged for the information. We have also distributed 500 copies among the newspapers of the country and have had nearly as many notices. In a number of cases we have supplied a city council with one or more copies by request, and it may be assumed that the edition has been very thoroughly distributed "where it will do the most good."

Proposals Open.

Stand Pipe, Tower and Tank.—Steel stand-pipe, and brick tower with iron tank on top, for the new water-works. LONG & DOUBLEDAY, Col mbus, Kan.

Railroad.—Double tracking between Lansdowne & Gananoque, and between Scarboro and York, on the line between Montreal and Toronto. Plans and specifications at the engineer's offices in Montreal and Toronto. JOSEPH HICKSON, General Manager, Grand Trunk Ry., Toronto, Canada. June 13rd (?).

Street Work.—Grading and constructing street: about 12,000 cu. yds. of excavation. ED. J. GREEN, Examiner, office of Sumwalt Ice Co., Baltimore, Md. June 6.

Sewers.—Vitrified pipe sewer, 8 and 10 ins. diam; manholes, and all appurtenances. W. J. FLANIGAN, City Clerk, Binghamton, N. Y. June 7.

River Improvement.—Improving the Warrior and Tombigbee rivers in Alabama and Mississippi. Major A. N. DAMRELL, U. S. Engineer Office, Mobile, Ala. June 7.

Paving.—Oblong granite and trap block paving, cobble stone paving, gutters, bridge stone, etc., JOHN HUNKELE, Street Commissioner, Newark, N. J. June 7.

Pumps and Boilers.—Two steam boilers and pumps, to be used on the Salt Reservation. P. J. BRUMSELKAMP, Superintendent, Onondaga Salt Springs, Syracuse, N. Y. June 8.

Locomotive Shops.—Excavation, masonry and brickwork for locomotive workshops at Stratford, Ont. Plans and specifications at the office of the Mechanical Superintendent, Stratford. JOSEPH HICKSON, General Manager, Grand Trunk Ry., Montreal, Canada. June 8.

Sewers.—In several streets. PERCIVAL W. ST. GEORGE, City Surveyor, Montreal, Canada. June 8.

Breakwater.—Stone, sand, cement and iron for the reconstruction of the superstructure of the breakwater at Buffalo. Capt. F. A. MAHAN, U. S. Engineer Office, Buffalo, N. Y. June 9.

Railroad.—Plans and specifications ready. W. J. STORMS, Secretary, Dallas & Oak Cliff Ry., 709 Main street, Dallas, Tex. June 10.

Dredging.—In the Hudson river; 20,000 cu. yds. at Mulls light and 8,000 cu. yds. at New Baltimore light. JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y. June 13.

Paving and Sewers.—JOHN NEWTON, Commissioner of Public Works, 31 Chambers street, New York City. June 14.

Artesian Well.—Bids per foot for 1,000 ft., for 1,500 ft., and for 2,000 ft. EDWARD PARSON, Chairman Committee, Raton Artesian Well Co., Raton, N. M. June 15.

Tube Wells.—A supply of 3,000,000 galls. per day is required from the ground of the old supply basin by means of tube filter wells (by gravity flow). ROBT. ALLSTATTER, President, Board of Water-Works Trustees, Hamilton, O. June 16.

Sewers.—W. P. RICE, City Engineer, Cleveland, O. June 16.

Ditch Work.—Montour Pond drain. The construction of 400 stations, and 100 ft. to each station. To be contracted for by the cubic yard, including the clearing and grubbing. SYLVESTER HORBALL, Drainage Commissioner, National Bank Building, Vincennes, Ind. June 18.

Iron Bridge.—Across Paint creek. WILLIAM H. EDWARDS, Coalburg, W. Va. June 19.

Asphalt Pavement.—Coal tar distillate and asphalt pavement in the Smithsonian grounds; about 2,500 sq. yds. Col. JOHN M. WILSON, U. S. A., Office of Public Buildings and Grounds, Washington, D. C. June 20.

Cast-Iron Pipe.—At Willet's Point, N. Y. HENRY C. HODGES, Dep. Q. M. G., U. S. A., Army Building, corner of Houston and Greene streets, New York City. June 20.

Court House.—Architects, Schrage & Nichols, Kansas City, Mo. JAMES SIMPSON, County Superintendent of Court House Construction, Fayette, Howard County, Mo. June 20.

Street Work.—Asphalt pavement fire clay brick or block pavement, setting curb. R. R. MARBLE, City Engineer, Columbus, O. June 20.

Armory.—Iron work, masonry, carpentry, plumbing and gas fitting, steam heating and ventilating. THE ARMORY BOARD, Mayor's Office, City Hall, New York City. June 20.

Buildings.—For the Hospital for the Insane at Norfolk, Neb., and for the Industrial School at Kearney, Neb., C. L. LAWS, Secretary, Board of Public Lands and Buildings, Lincoln, Neb. June 25.

Sewers.—WM. ALLEN VEACH, City Clerk, Newark, O. June 28.

Bridges.—Six bridges and one culvert. Plans and specifications prepared by the County Engineer, on file in the office of the County Clerk. J. W. NIEHAUS, County Clerk, Leavenworth, Kan. July 5.

Water Works.—Time extended. EDWIN S. LOOMIS, City Clerk, Fernandina, Fla. July 15.

Bridge and Trestle.—Iron bridge of 3 spans of 120 ft. each, and 500 ft. of trestle work. JOHN T. COOPER, Clerk of the County Commissioners, Atlanta, Fulton county, Ga. July 18.

Contracting.

Water Works.—Col. MONROE, of Providence, R. I., has the contract for the water-works at Bismarck, Dak.

Proposals for Sewers.—In our advertising pages will be found an advertisement for proposals for the construction of brick and stone sewers at Pittsburg, Pa. E. M. BIGELOW, City Engineer.

Sewers.—The following proposals for constructing a cylindrical brick sewer, 24 ins. inside diameter, 4-in. shell, were opened May 23 by the City Council, Toledo, O.; M. C. Galvin, sewer, $1.49 per lin. ft.; catch basins, $30; manholes, $7; sand, $7; lumber, $15. W. H. and J. J. Leith: $1.52, $40, $6, $7, $20. Thomas Kelley: $1.62 $60, $15, $7, 120. Wm. McMahon, $1.64, $40, $11, $7, $30.

Flagging.—The following proposals for flagging sidewalks, were opened May 20 by the Commissioner of of City Works, Brooklyn, N. Y.; Charles S. Lynan, 20 cts. per sq. ft.; Thomas R. McCann, 21 cts. per sq. ft.

Water Pipe.—The Water Works Co., New Albany, Ind., has awarded the contract for 20-in. mains to Dennis Long & Co., of Louisville, Ky., for about $35,000.

Granite Curb.—The following proposals for 6 in. granite curb were opened May 27 by A. E. SMYRK, City Commissioner, Baltimore, Md.: W. F. Weiler, 89 cts. per lin. ft.; Brandywine Granite Co., Wilmington, Del. 90 cts.

Granolithic Pavement.—The following proposals were opened May 28 by Col. T. L. CASEY, Engineer Office, Washington Monument, Washington, D.C.: Schillinger Artificial Stone Co., Washington, 47½ cts. per sq. ft.; H. L. Cranford, Washington, 50 cts. per sq. ft.

Stop Valves and Plugs.—The following proposals were opened recently for supplies for the Water Department, St. Louis, Mo.: For 12 8-in. stop valves; Fulton Iron Works, $35 each; St. Louis Iron & Machine Works, $37.80. For 150 underground fire plugs; Standard Foundry Co., $21 each; St. Louis Iron & Machine Works, $22.40; Fulton Iron Works, $22.70.

Road Work.—The following proposals for improving the Bladensburg road have been received by WM. LUDLOW, Engineer Commissioner, Washington, D. C.: H. Waters; grading, 30 and 37 cts.; macadam $1.20; macadam with Telford base, $1; cobble gutters, 45 cts., rubble masonry, $18; filling sub drains, $3.50. Talty & Joyce, 35 and 28 cts.; $1.10, $1.35, 40 cts., $4.25, $2.

Macadam.—Proposals for furnishing and delivering macadam for twelve districts and the Columbia Bottom road were opened recently by HENRY FLAD, President of the Board of Public Improvements, St. Louis, Mo. The prices ranged from $3.19 to $7.43, according to the district to be supplied. The following were the bidders, the work being let separately for each district: Robert Zesch, Henry Zeiss, Jr., G. Eyermann, Louis Grund, Stifel & Ruckert, St. Louis Quarry Co., Adam Kern, Daniel Cavanagh, J. E. Perkinson, Fruin Bambrick Construction Co., and D. Scharringhausen.

Cement and Stone.—The following proposals were opened May 24 at the office of Building for State, War and Navy Department, Washington, D. C: Natural hydraulic cement, 800 barrels; J. G. and J. M. Waters, $1.12 per bl.; Joseph M. Wheatley, $1.12. Broken stone, 275 cu. yds.; Hugh Waters, $1.85 per cu. yd.; Barber Asphalt Paving Co., $2. Portland cement floor, 11,100 sq. ft.; Schillinger Artificial Stone Co., 12 cts. per sq. ft. laid in place; H. L. Cranford, 13.5 cts.; Geo. Drew, 14.9 cts. All the bidders were local parties. BERNARD R. GREEN is Assistant Engineer.

Tunnel.—The following proposals were opened May 28 by S. H. SHEARER, City Engineer, Indianapolis, Ind.: For tunnel complete: E. B. Hegge, Indianapolis $29,000; Canton Wrought Iron Bridge Co., Canton, O., $30,000; Whittsitt & Adams, Indianapolis, $36,750; Pittsburg Bridge Co., $37,800; Morse Bridge Co., Youngstown, O. $40,975. Iron work erected; C. J. Schultz, Pittsburg, $13,450; Massillon Bridge Co., Massillon, O., $14,500; Morse Bridge Co., $17,650. Stone work only; Wm. Petrie, Indianapolis, $7,689. The contract has been awarded to E. B. Hegge. The viaduct work, for which the plans have been prepared, will be let about the end of the month.

Sewer Work.—At Providence, R. I., contracts have been awarded as follows: Sewer pipe, Henry A. Warner, New Haven, Conn.: 15-in. pipe, 68¾ cts.; 12-in., 46¾ cts.; 8-in., 24¾; 15 x 6-in. branches, $1.26 per ft.; 12 x 6-in., 85½ cts.; 8-in. curved pipes and bends, 99 cts. each; 12-in. bends, $1.92½; 8-in. inverts, 24¾ cts. per ft. Flagstones, 5 ft. x 5 ft. x 4 ins., Mayatt Brick Co., Providence; 27 cts. per sq. ft. Iron work, Fuller Iron Works, Providence; manhole steps and Croes' traps, 2¼ cts. per pound; catch basin covers and manhole frames and covers, 1¾ cts. per pound. SAMUEL M. GRAY is City Engineer.

Artesian Well.—The Lebanon Water Co., of Lebanon, Mo., has awarded the contract for drilling the well to Messrs. Grey Bros., of Milwaukee, Wis., and the plant is now in position to commence work. The contract price is $3 per ft. for the first 1,000 ft. with a rising scale to $1,500 ft.; the contractor is guaranteed 600 ft. but should an abundance of water be reached at a less depth, the water company may apply the balance of the $1,800 in enlarging from a 6-in. to 8-in. bore, at the rate of $1.80 per ft. Natural gas in small quantities is issuing from a 120 ft. well a quarter of a mile away, and as there is no well deeper than 200 ft. within 50 miles the result of the new well is looked for with some interest. M. W. SEEL is President of the company.

Brick Paving.—At Chattanooga, Tenn., there is talk of putting down brick pavement. Nashville parties have agreed to put down a couple of blocks of creosoted brick on 1½-in. concrete, after the city has made the excavation, for $1.85 per yd., as an experiment. The city failed to vote for bonds to improve the streets, and proper y owners are signing agreements to pay for the pavement in front of their respective properties, provided the cost does not exceed a certain specified amount.

Water Works Supplies.—The following proposals were opened May 25 by the Water Commissioners, Montreal, Canada: Pig lead; Montreal Rolling Mills Co., $73.94 per ton (2,240 pounds); Jas. Robertson, $75; Bellhouse & Dillon, $77.38. Awarded to the Montreal Rolling Mills Co.——Lead pipe, ¾, ¾ and 1 in.; Jas. Robertson, $98.32½ per ton; Montreal Rolling Mills Co., $99.40. Awarded to Jas. Robertson.——Special castings; B. Scott, $43.75 per ton; John McDougall, $45.70; P. Ameese, $47.60; E. Chanteloup, $50; Wm. Clendinning & Son, $55; Thos. Scanlan, $55. Awarded to John McDougall.——Brass work, ½-in. shell stop cocks, with couplings; E. Chanteloup, 25 cts. per pound; Garth & Co., 80 cts. each. Awarded to E. Chanteloup.

Street Work.—The following contracts for regulating and paving were awarded May 26 at the Department of Public Works, New York City: On 155th street; F. Erving, filling 38 cts, per cu. yd.; curbing, 65 cts. per lin. ft.; flagging, 36 cts. per sq. ft.; total, $2,498.—On 67th street; no award made; the lowest bidder was Wm. A. Cumming, $2.37 per sq. yd.; $6,557.60.——On 68th street; Wm. A. Cumming, pavement, $2.38 per sq. yd.; $6,592.04.——On 68th street; Matthew Baird, $2.43; $10,055.38 ——On 80th street; Wm. A. Cumming, $2.45; $6,786 15——On 81st street; John B. Devlin, $2.34; $12,796.——On 95th street; P. H. Fitzgerald; $2.49; $6,852.90.——On 84th street; P. H. McCullach, pavement, $2.27 per sq. yd.; bridge stone, 60 cts. per sq. yd; total, $5,295.80.

Dredging.—The following proposals for dredging 30,000 cu. yds. at Covilles Folly, Hudson river, were opened May 23 by JAMES SHANAHAN, Superintendent of Public Works, at Albany, N. Y.: Lamont Sanford, Buffalo, 29¾ cts. per cu. yd.; John Brown, Mohawk, 32½ cts.; P. W. Myers, Albany, 41⅞ cts.; E. M. Payn, Albany, 44¾ cts. The contract was awarded to Lamont Sanford.——At Round shoal: Chas. Brown, Mohawk, 22¾ cts.; E. M. Payn, Albany, 43.9 cts.; P. W. Myers, Albany, 44.7 cts. Contract awarded to Chas. Brown.——At upper railroad bridge: Chas. Brown, 22¾ cts.; E. M. Payn, 43¾ cts.; Robert Jones, Cohoes, 48¼ cts. Contract awarded to Chas. Brown.

The following proposals were opened May 25 by the President of the Harbor Board, Baltimore, Md.: Baltimore Dredging Co.; channels and harbor, 13¾ cts. per cu. yd.; sand and clay, 32½ cts.; Back basin and docks, 17 cts.; Spring gardens, 14½ cts. Canton Dredging Co., 13¾, 35, 17 and 14¾ cts. C. W. Nelson, Jr.; 11, 30, 15¼ and 11 cts. L. J. Fobes; 13¼, 35, 17¾ and 14¼ cts.

The following proposals for dredging and embankment in the Potomac river were opened May 28 by Lieut. Col. PETER C. HAINS, U. S. Engineer Office, Washington, D. C.: F. C. Somers, Philadelphia; Class A, 15 cts., B, 32 cts., C, 23 cts.; total, $25,850. Thos. P. Morgan, Washington, proposed to furnish a clam shell dredge at $4.50 per hour.

Bridge Contracts.—The Edge Moor Iron Works, Wilmington, Del., have been awarded the contract for the superstructure of the wagon and street car bridge between Omaha, Neb., and Council Bluffs, Ia.; and Hopkins & Scully have the contract for the substructure. The bridge will cost $405,000.

W. G. Coolidge & Co., Chicago, Ill., have been awarded the contract for all the Howe truss bridges, 19 spans, on the Minneapolis, Sault Ste. Marie & Atlantic Ry., and for the Howe truss bridges on the Merrill & Albany extension of the Chicago, Milwaukee & St. P ul Ry.

The Union Bridge Co. has the contract for the new bridge for the Illinois Central R.R. over the Ohio river at Cairo, Ill.

The King Iron Bridge & Manufacturing Co., Cleveland, O., has the contract for an iron bridge at Florence, Ala., for $3,700.

The Kansas City Bridge & Iron Co. has the contract for a combination, iron and wood, bridge of 3 spans, for the Wyandotte & Northwestern R. R. across the Kaw river. It will be 480 ft. long and will cost $65,000.

The Smith Bridge Co., Toledo, O., has the contract for a bridge of 132 ft. span at Wilmington, N. C. There will be two 20 ft. roadways and two 10 ft. sidewalks.

McManis & Sons, Princeton, Ill., have the contract for an iron bridge across Brush creek, to cost $1,500.

The Phœnix Bridge Co., New York, has the contract for an iron bridge across the Mohawk river at Fort Plain, N. Y. It will have a span of 325 ft., and be 30 ft. wide. The contract price is $34,500.

The Groton Bridge Co., Groton, N. Y., has been awarded the contract for an iron bridge across the river at Great Barrington, Mass.

John H. Willey has the contract for the bridge over Cohas brook at Manchester, N. H.

Foundations, Sewers, Etc.—The following proposals were opened May 26, at the Department of Public Works, New York City, for foundations for a coal storage house on 96th and 97th streets, for a sewer across the lot and for a tunnel across 97th street to the vault of the present engine house. The contract was awarded to Robert Hanna:—

		Robert Hanna.	F. Thileman.	J. B. Devlin.	John Cox & Co.	B. Mahon.
Rock excavation	per cu. yd.	$ 2.50	$ 2.50	$ 2.25	$ 1.85	$ 4.50
Earth	" " "	.60	.65	.25	.99	.90
Cut stone masonry	" " "	11.00	8.00	8.00	48.00	50.00
Stone	" " "	4.95	4.25	5.00	7.80	7.00
Concrete	" " "	4.98	4.00	4.75	6.45	7.00
Brick	" " "	9.50	14.00	10.00	13.00	17.00
Flagging	" sq. ft.	.30	.40	.85	.27	.90
Curbing	" lin. ft.	.65	.40	.75	1.00	.90
Sewers and manholes	" " "	1.95	2.00	.50	4.85	5.00
Pipe, 4-in.		.60	1.00	.25	.78	1.00
Totals		$24,007.10	$24,392.50	$27,297.50	$28,037.60	$44,485.

Harbor Work.—The following was the only proposal received for repairs, etc., at Port Clinton harbor, O., and opened May 23, by MAJOR L. COOPER OVERMAN, U. S. Engineer Office, Cleveland, O.: John Stang, Lorain, O.; white oak, $39 per 1,000 ft. B. M.; piles, 35 cts. per lin. ft.; filling stone, $5.50 per cord; riprap, $5.50 per cord; brush, $3.50 per cord; drift bolts, 3 cts. per pound; spikes, 4 cts. per pound; wharf bolts, 4 cts. per pound; total, $1,905.79.

Sewers.—The following proposals were opened May 25 at the Department of Public Parks, New York City: (1) Sewers in 169th street and 3rd avenue: Chas. Jones, $25,112; M. J. Leahy, $25,675 90; V. E. Horton, $31,396.70; John P. Kerrigan, $34,917; John McQuade, $36,685; B. C. Murray, $39,339; Geo. F. Masterson, $47,505. The contract was awarded to Chas. Jones at the following prices: Brick sewers, 26x36 and 20x30, $6.50 and $6; pipe sewers, 18, 15 and 12-in., $4, $4 and $4.50; house connections, 25 cts.; manholes, $38; receiving basins, $150; rock excavation, $3.80; lumber, $40; concrete, $1 per cu. yd.

(2) Sewer on 164th street; John Kerrigan, $3,117; Wm Mansfield, $3,220; John McQuade, $3,362; B. C. Murray, $3,516; Jos. Moore, $4,423. Geo. Tillaston. Contract awarded to John Kerrigan.——(3) Sewer on 148th street; John McQuade, $3,124.50; Wm. Mansfield, $3,405; B. C. Murray, $3,569.50; Jos. Moore, $3,612.60; J. J. Montgomery, $3,803.20. Contract awarded to John McQuade.——(4) Sewer on Clifton street; M. J. Leahy, $6,413.25; John McQuade, $6,960; B. C. Murray, $7,519.50; Wm. Mansfield, $7,591.10 (informal); J. P. Kerrigan; $8,260; Jos. Moore, $8,914.25; Geo. F. Masterson, (informal). Contract awarded to M. J. Leahy.——(5) Sewer on the Southern Boulevard; V. E. Horton, $3,906.80; B. C. Murray, $5,071.40; Jos. Moore, $5,305.75; John McQuade, $5,683; Wm. Mansfield, $5,727.50; John J. Montgomery, $5,912.13; Geo. F. Masterson, $11,541.50. Contract awarded to V. E. Horton.——(6) Trap-block paving on Westchester avenue; E. N. Lynch, $11,077.50; Matthew Baird, $11,103.75; P. H. Fitzgerald, $11,383.75. Contract awarded to E. N. Lynch, at $2.50 per sq. yd.

Railroad Contracts.—Hugh Burns has sublet to J. Marshall, of San Antonio, Tex., a contract for grading 12 miles on the San Marcos branch of the Missouri Pacific.

Grant Brothers, contractors for the Riverside, Santa Ana & Los Angeles R. R., in California, are pushing the work.

G. W. Hunt has the contract for grading, bridges, trestles, ties and track laying on the Pendleton & Walula R. R., in Oregon; the line will be 35 miles long, with a branch of 15 miles to Centerville.

The Alabama Terminal Improvement Co. (J. W. Wolfolk, of Montgomery, president,) has the contract for building the Alabama Midland Ry. from Montgomery to Chattahoochee.

Thomas Earle & Co. have the contract for building the Seattle & West Coast Ry. from Seattle, Wash. T., to Snohomish City.

W. S. Heckart has the contract for 10 miles of the Glenwood & Aspen extension of the Denver & Rio Grande R. R. His section commences at Aspen, Col.

H. C. Griffin, Sanford, Fla., has the contract for building the Orange Belt R. R. from Oakland, Fla., to Point Pinellas.

W. B. Lowe & Co., Augusta, Ga., have the contract for the Augusta & Chattaneoga R. R., 240 miles.

Wright & Co., Monroe, N. C.; W. P. Fortune, Monroe, N. C., and the North Carolina Penitentiary, have contracts on the Georgia, Carolina & Northern R. R., 267 miles.

Orman & Crook, Pueblo, Col., have the contract for grading 30 miles of the extension of the Denver & Rio Grande R. R. from Montrose to Ouray.

T. B. Innes is reported to have given up his contract on the Tybee R. R., in Georgia. The company will complete the work, with Superintendent Haines in charge.

J. H. McLane, of Michigan, has the contract for the last section of the Mobile & Birmingham R. R., between Marion Junction, Ala., and Choctaw Corner. Work to be completed by October.

Caisson.—The only proposal received for the construction of the caisson for the dry dock at Boston, Mass., and opened May 25 by D. B. HARMONY, Chief of Bureau of Yards and Docks, Navy Department, Washington, D. C., was from the Atlantic Works, East Boston, at $37,800, which was $6,800 in excess of the appropriation. The work will be readvertised.

City Work.—The following contracts were awarded May 26 at the Department of Public Works, New York City: Limestone screenings; Wm. M. McDonald, $2.40 per cu. yd., $1,740.——Roa Hook gravel and gravel screenings; Geo. F. Doak, $2.19 and $1.68, $9,756.——Concrete floor at Tompkins market; John Cox & Co., $2,450.——Laying water mains; J. Cornwell, Jr., at the following prices: rock excavation, $1.75; earth excavation, 20 cts.; filling, 10 cts.; laying 12 and 6-in. pipe, 36 and 26 cts. per ft.; 12 and 6-in. stop cocks and boxes, $6 and $5; hydrants, $5; paving and flagging, 20 cts. per sq. ft.; curbing, 2 cts. per ft., brick masonry, $3 per cu. yd.; total, $7,755. The other bidders were F. Thileman, $7,857 and B. Mahon, $8,070.

Bridges, Canals, Etc.

Bridge Notes.—Albany, N. Y. The bill for a viaduct in Hawk street over Canal street has become a law by expiration and without the Governor's signature. When the council authorizes the construction of the viaduct, the mayor is to appoint three commissioners to examine plans for the structure.——Manasquan, N. J. The Board of Freeholders of Monmouth county has decided to improve the bridge across the Manasquan river and put in a draw.——Pottstown, Pa. The jury named by the Courts of Montgomery and Chester counties to view the site for a proposed bridge across the Schuylkill at Pottstown, has reported in favor of the erection of a bridge. It will be about 300 ft. long, and is estimated to cost $20,000; $12,000 for iron work, and $8,000 for excavation, masonry, etc.——Chattanooga, Tenn. A bridge will be built across the Tennessee river by the East Tennessee, Virginia & Georgia and the Richmond & Danville railroads jointly.——Savannah, Ga. The County Commissioners have directed the County Engineer to prepare plans and an estimate of cost for a bridge, or bridges, necessary to connect Skidaway island with Isle of Hope. All the bids for the bridge on the Isle of Hope causeway have been rejected, and the bridge will be built by the commissioners.——Alton, Ill.—E. C. HAYWARD, Assistant Engineer of the Central Missouri R. R., has commenced borings and preliminary operations for the bridge across the Mississippi.——Chicago, Ill. A petition has been presented to the mayor asking that a double track bridge be built across the river at State street, instead of the single track one about to be built. In opposition it is claimed that a wide bridge would be dangerous to river traffic unless the river is widened and straightened. The bridge is for the Chicago & Northwestern R. R.——Sturgeon Bay, Wis. The Sturgeon Bay Bridge Co. has been incorporated by RUFUS C. KELLOGG, JOHN LEATHEEN and THOS. H. SMITH, all local parties. Capital stock, $21,000.——Kansas City, Mo. The citizens of Delaware township will hold an election June 18 to vote $15,000 in bonds for a highway bridge across the Kaw river near Tiblow, on condition that the same amount is voted by Monticello township, Jackson county.——Aberdeen, Miss. The Kansas City, Birmingham & Memphis R. R., will build an iron drawbridge over the Tombigbee river at Aberdeen, for its branch to that place. The bridge will cost between $40,000 and $50,000.——Galveston, Tex. The question of a bridge to the mainland is again being agitated. A company, with a capital stock of $200,000 or $300,000, is being organized to build an iron bridge, with stone abutments and piers; the bridge will be for railroad and highway traffic. It is proposed that the county shall pay $25,000, and the railroad companies $30,000 per annum; the bridge company undertaking the construction and maintenance of the bridge.——El Paso, Tex. An iron bridge is proposed across the Rio Grande river; it will be a toll bridge unless the county contributes a sufficient amount to make the bridge free.

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